Pressurized Payloads
Interface Requirements Document

International Space Station Program

September 4, 2003

Revision G

Type 1 – NASA Approved

National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center
Houston, Texas
Contract No. NAS9–02099 (PA06)

REVISION AND HISTORY PAGE

REV.	DESCRIPTION	PUB. DATE
–	Initial Release per DR PA06	07–25–97
A	Revision A (Reference per SSCD 000887, EFF. 11/12/97). Revision A incorporates the following PIRNs: 57000–NA–0008B, 57000–NA–0011B, 57000–NA–0018A, 57000–NA–0019B, 57000–NA–0021A, 57000–NA–0027A, 57000–NA–0028A, 57000–NA–0030A, 57000–NA–0032, 57000–NA–0033, 57000–NA–0034A, 57000–NA–0035, 57000–NA–0036, 57000–NA–0038A, 57000–NA–0040A, 57000–NA–0044A	02–18–98
B	Revision B (Reference per SSCD 001168, EFF. 9/14/98) Revision B incorporates the following PIRNs: 57000–NA–0007C, 57000–NA–0009D, 57000–NA–0010B, 57000–NA–0012C, 57000–NA–0013B, 57000–NA–0014C, 57000–NA–0015C, 57000–NA–0016B, 57000–NA–0017C, 57000–NA–0020A, 57000–NA–0022C, 57000–NA–0024D, 57000–NA–0026B, 57000–NA–0029E, 57000–NA–0031B, 57000–NA–0039C, 57000–NA–0041C, 57000–NA–0042A, 57000–NA–0043A, 57000–NA–0045B, 57000–NA–0047, 57000–NA–0048, 57000–NA–0049A, 57000–NA–0050A, 57000–NA–0051A, 57000–NA–0052A, 57000–NA–0053A, 57000–NA–0054B, 57000–NA–0055, 57000–NA–0056, 57000–NA–0057C, 57000–NA–0058, 57000–NA–0059, 57000–NA–0060A, 57000–NA–0061, 57000–NA–0062, 57000–NA–0063B, 57000–NA–0064B, 57000–NA–0065, 57000–NA–0066B, 57000–NA–0067, 57000–NA–0068B, 57000–NA–0069A, 57000–NA–0070A, 57000–NA–0071A, 57000–NA–0072A, 57000–NA–0073A, 57000–NA–0074A, 57000–NA–0075, 57000–NA–0076B, 57000–NA–0077, 57000–NA–0078A, 57000–NA–0079A, 57000–NA–0080A, 57000–NA–0081A, 57000–NA–0082A, 57000–NA–0083A, 57000–NA–0084, 57000–NA–0085A, 57000–NA–0087, 57000–NA–0088A, 57000–NA–0089A, 57000–NA–0090, 57000–NA–0091A, 57000–NA–0092A, 57000–NA–0093A, 57000–NA–0096A, 57000–NA–0097, 57000–NA–0098A, 57000–NA–0099A, 57000–NA–0100B, 57000–NA–0101C, 57000–NA–0102, 57000–NA–0103B, 57000–NA–0104C, 57000–NA–0105, 57000–NA–0106C, 57000–NA–0107A, 57000–NA–0108	11–04–98
C	Revision C (Reference per SSCD 001822, EFF. 4/28/99). Revision C incorporates the following PIRNs: 57000–NA–0109B, 57000–NA–0111A, 57000–NA–0112A, 57000–NA–0113, 57000–NA–114D, 57000–NA–0115A, 57000–NA–0116C, 57000–NA–0117A, 57000–NA–0119B, 57000–NA–0120, 57000–NA–0121B, 57000–NA–122D, 57000–NA–0123A, 57000–NA–0126C, 57000–NA–0127B, 57000–NA–0128A, 57000–NA–0129A, 57000–NA–0130, 57000–NA–0131A, 57000–NA–0133A, 57000–NA–0135H, 57000–NA–136C, 57000–NA–0137	07–08–99

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REV.	DESCRIPTION	PUB. DATE
D	Revision D (Reference per SSCD 002533, EFF. 08/02/99). Revision D incorporates the following PIRNs: 57000–NA–0132D, 57000–NA–0139B, 57000–NA–0140A, 57000–NA–141, 57000–NA–0143A, 57000–NA–0146A, 57000–NA–0147A, 57000–NA–149, 57000–NA–0150C, 57000–NA–0152A, 57000–NA–0153, 57000–NA–154, 57000–NA–0155, 57000–NA–0156A, 57000–NA–0157A, 57000–NA–0158, 57000–NA–0159, 57000–NA–0160, 57000–NA–0162A, 57000–NA–0163A, 57000–NA–164B, 57000–NA–0165A, 57000–NA–0166B, 57000–NA–0167, 57000–NA–0168B, 57000–NA–0170, 57000–NA–0174A, 57000–NA–0177A	11–16–99
E	Revision E (Reference per SSCD 003132, Rev. F, EFF. 02–21–01). Revision E incorporates the following PIRNs: 57000–NA–0151H, 57000–NA–0161C, 57000–NA–0179, 57000–NA–0180, 57000–NA–0181C, 57000–NA–0182, 57000–NA–0183A, 57000–NA–0184A, 57000–NA–0185A, 57000–NA–0189, 57000–NA–0190B, 57000–NA–0191A, 57000–NA–0192, 57000–NA–0193B, 57000–NA–0194, 57000–NA–0195E, 57000–NA–0196, 57000–NA–0202, 57000–ES–0001A, 57000–ND–0003C	4–18–01
–	IRN 0001 incorporates the following: SSCD 003970 incorporates PIRN 57000–NA–0205A SSCD 004176 incorporates PIRNS 57000–NA–0198A, 57000–NA–0203, 57000–NA–0208, 57000–NA–0222, 57000–NA–0235A	11–20–01
–	IRN 0004 per SSCD 005833, EFF. 11/06/01	02–26–02
–	IRN 0003 per SSCD 003664 R1, EFF. 06/07/02	08–29–02
–	IRN 0005 per SSCD 005717, EFF. 07/29/02	11–25–02
–	IRN 0002 per SSCD 005244, EFF. 05/31/02 Revision E IRN 0002 is the first release on the IPIC Contract.	07–30–03

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REV.	DESCRIPTION	PUB. DATE
F	Revision F per SSCD 007441 – EARLY RELEASE SSCD 005453 R1 incorporates PIRNs 57000–NA–0134F, 57000–NA–0175C SSCD 006251 R1 incorporates PIRNs 57000–NA–0148B, 57000–NA–0176H, 57000–NA–0238A, 57000–NA–0241D, 57000–NA–0242, 57000–NA–0252C, 57000–NA–0255, 57000–NA–0258A, 57000–NA–0265 SSCD 006892 R2 incorporates PIRNs 57000–NA–0197D, 57000–NA–0253D, 57000–NA–0254B, 57000–NA–0260B, 57000–NA–0267, 57000–NA–0269B	07–31–03
F	Revision F – Approved	01–27–04
G	Revision G per SSCD 008152 – EARLY RELEASE Revision G incorporates the following PIRNs: 57000–NA–0188B, 57000–NA–0272A, 57000–NA–0273A, 57000–NA–0274A, 57000–NA–0276E, 57000–NA–0277D, 57000–NA–0278D, 57000–NA–0279, 57000–NA–0285, 57000–NA–0287B, 57000–ND–0005	11–19–03
G	Revision G per SSCD 008152 – APPROVED Revision G incorporates the following PIRNs: 57000–NA–0188B, 57000–NA–0272A, 57000–NA–0273A, 57000–NA–0274A, 57000–NA–0276E, 57000–NA–0277D, 57000–NA–0278D, 57000–NA–0279, 57000–NA–0285, 57000–NA–0287B, 57000–ND–0005 Rev G closes SSCN 001510 which was incorporated by PIRN 57000–NA–0146A in Revision D. Rev G closes SSCN 002581 which was incorporated by PIRNs 57000–NA–0184A & 5700–NA–0185A in Revision E. Rev G closes SSCN 003410 which was incorporated by PIRN 57000–NA–0223D in IRN 0002. Rev G closes SSCN 003928 which was incorporated by PIRN 57000–NA–0253D in Revision F. Rev G closes SSCN 005389 which was incorporated by PIRN 57000–NA–0254B in Revision F.	08–24–04

ERU: /s/ M. Hehn 08–24–04

INTERNATIONAL SPACE STATION PROGRAM

PRESSURIZED PAYLOADS INTERFACE REQUIREMENTS DOCUMENT

PREFACE

This document defines the minimum Space Station Requirements for Pressurized Payloads and provides requirements for incorporation in the National Aeronautics and Space Administration (NASA) Space Station hardware procurements and technical programs. The traceability of these requirements into International Partners pressurized payload requirement documents would ensure certification for integration into ISS modules (i.e., USL, APM, JEM, MPLM, and CAM). The Space Station Pressurized Payloads Interface Requirements document contains an introduction, a list of applicable documents, subsections on general and detailed interface and payload specific design requirements, subsections on verification requirements, along with appendices containing acronyms, and definitions. This document defines and controls required interfaces for compatibility with the International Space Station (ISS). The applicability of these requirements will depend upon the characteristics of the integrated rack payloads as specified in the individual Payload Integration Agreement (PIA). The interface design requirements outlined in this document are mandatory and may not be violated unless specifically agreed upon in the individual Interface Control Document (ICD). Space Station Pressurized Payloads Interface Requirements will be implemented on all NASA rack level payload provider contractual and internal activities and will be included in any existing contracts through contract changes. This document is under the control of the ISS Multilateral Payloads Control Board (MPCB), and any changes or revisions will be approved by the MPCB.

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INTERNATIONAL SPACE STATION PROGRAM

PRESSURIZED PAYLOADS INTERFACE REQUIREMENTS DOCUMENT

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INTERNATIONAL SPACE STATION PROGRAM
PRESSURIZED PAYLOADS INTERFACE REQUIREMENTS DOCUMENT

LIST OF CHANGES

All changes to paragraphs, tables, and figures in this document are shown below:

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
000887	12–NOV–97	57000–NA–0001B	4.3.5.1.9
		57000–NA–0002A	3.5.1.2B
		57000–NA–0003B	2.1
		57000–NA–0028A	2.1
		57000–NA–0004B	PREFACE
		57000–NA–0006B	3.1.1.2B
		57000–NA–0008B	3.2.1.4
		57000–NA–0011B	4.3.2.1.4
		57000–NA–0018A	3.2.1
		57000–NA–0019B	3.2.4.3
		57000–NA–0027A	3.2.3.1
		57000–NA–0032	3.5.1.11
		57000–NA–0033	3.10.3.2
		57000–NA–0034A	3.1.2.5
		57000–NA–0035	3.7.6
		57000–NA–0036	3.12.2.2
		57000–NA–0038A	3.12.4.3.9
		57000–NA–0040A	3.10.2.1.2, 3.12.1, 3.12.7.5, 3.12.7.5.1, 4.3.12.7.5, 4.3.12.7.5.1
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		57000–NA–0030A	3.9.3.4–1
		57000–NA–0044A	3.1.1.3–1
			FIGURE(S)
		57000–NA–0021A	3.2.2.9–1
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001168	23–APR–98	57000–NA–0007C	Appendix B, 2.1, 3.12.3.4, 4.3.12.3.4

SSCBD	ENTRY DATE	CHANGE	TABLE(S)
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		57000–NA–0009D	3.2.2.8
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		57000–NA–0010B	3.2.2.10
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		57000–NA–0012C	4.3.2.2.3
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		57000–NA–0013B	4.3.2.2.9
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		57000–NA–0014C	4.3.2.5.3
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		57000–NA–0015C	4.3.2.5.4
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		57000–NA–0016B	4.3.2.5.5
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		57000–NA–0017C	3.2.2.6.1.1
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		57000–NA–0020A	3.2.1.3.3–1
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		57000–NA–0022C	3.2.5.6, 4.3.2.5.6, 3.2.6, 4.3.2.6, 3.2.6.1, 4.3.2.6.1, 3.2.6.2, 4.3.2.6.2, 3.2.6.2.1, 4.3.2.6.2.1, 3.2.6.2.2, 4.3.2.6.2.2, 3.2.6.2.3, 4.3.2.6.2.3, 3.2.6.2.4, 4.3.2.6.2.4, 3.2.6.2.5, 4.3.2.6.2.5, 3.2.6.3, 4.3.2.6.3, 3.2.6.4, 4.3.2.6.4, 3.2.6.4.1, 4.3.2.6.4.1, 3.2.6.5, 4.3.2.6.5
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		57000–NA–0029E	3.1.1.6, 4.3.1.1.6, 3.1.1.4, 4.3.1.1.4, 3.2.2.1, 4.3.2.2.1, 3.3.5.2.1.2, 4.3.3.5.2.1.2, 3.3.5.2.1.3, 4.3.3.5.2.1.3, 3.3.6.1.4, 4.3.3.6.1.4, 3.3.6.1.4.1, 4.3.3.6.1.4.1, 3.3.6.1.4.2, 4.3.3.6.1.4.2, 3.3.6.1.4.4, 4.3.3.6.1.4.4, 3.3.7.6, 4.3.3.7.6, 3.3.7.7, 4.3.3.7.7, 3.3.9, 3.3.10.3, 4.3.3.10.3, 3.4.1.2.6, 4.3.4.1.2.6, 3.4.1.2.7, 4.3.4.1.2.7, 3.4.1.3.2, 4.3.4.1.3.2, 3.4.1.4, 4.3.4.1.4, 3.5.1.1, 4.3.5.1.1, 3.6.1.1, 4.3.6.1.1, 3.6.2.1, 4.3.6.2.1, 3.7.1.5, 4.3.7.1.5, 3.7.2.5, 4.3.7.2.5, 3.7.2.5, 4.3.7.2.5, 3.7.4.5, 4.3.7.4.5, 3.8.1.1, 4.3.8.1.1
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		57000–NA–0031B	3.2.4, 4.3.2.4
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		57000–NA–0039C	3.12.6.4.1, 4.3.12.6.4.1
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		57000–NA–0041C	3.12.5.2.1
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		57000–NA–0042A	3.12.4.3.11, 4.3.12.4.3.11
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		57000–NA–0043A	3.2.3.2
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		57000–NA–0045B	3.5.1.2, 3.5.1.14, 3.5.1.16, 3.5.1.17
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		57000–NA–0047	3.5.1.15, 4.3.5.1.15

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		57000–NA–0048	3.1.2.5, 4.3.1.2.5, 2.1
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		57000–NA–0049A	3.10.3.1, 4.3.10.3.1
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		57000–NA–0050A	3.12.7.5.13, 4.3.12.7.5.13
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		57000–NA–0051A	3.5.1.11, 4.3.5.1.11
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		57000–NA–0052A	3.5.1.9, 4.3.5.1.9, 3.5.1.14, 4.3.5.1.14
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		57000–NA–0053A	3.3.2.3, 4.3.3.2.3, 4.3.3.4.2.2
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		57000–NA–0054B	2.1, 3.1.1.4, 4.3.1.1.4
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		57000–NA–0055	2.1, 3.8.2
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		57000–NA–0056	3.4.1.1, 3.4.1.2.1, 3.4.1.2.4
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		57000–NA–0057C	3.5.1.6, 4.3.5.1.6
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		57000–NA–0058	4.3.3.4.1, 4.3.3.4.1.1, 4.3.3.4.1.1.1, 4.3.3.4.1.1.2, 4.3.3.4.1.2, 4.3.3.4.1.3, 4.3.3.4.1.4, 4.3.3.5, 4.3.3.5.1.1, 4.3.3.5.1.2, 4.3.3.5.1.3, 4.3.3.5.1.4, 4.3.3.5.1.10
			PARAGRAPH(S)
		57000–NA–0059	4.3.1.1.1
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		57000–NA–0060A	3.12.6, 4.3.12.6
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		57000–NA–0061	3.7.1.3, 3.7.2.3, 3.7.3.3, 3.7.4.3

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0062	3.12.3.3, 4.3.12.3.3, 3.12.3.3.1, 4.3.12.3.3.1, 3.12.3.3.1.1, 4.3.12.3.3.1.1, 3.12.3.3.1.2, 4.3.12.3.3.1.2, 3.12.3.3.1.3, 4.3.12.3.3.1.3, 3.12.3.3.1.4, 4.3.12.3.3.1.4, 3.12.3.3.2, 4.3.12.3.3.2, 3.12.3.3.2.1, 4.3.12.3.3.2.1, 3.12.3.3.2.2, 4.3.12.3.3.2.2, 3.12.3.3.2.3, 4.3.12.3.3.2.3, 3.12.3.3.3, 4.3.12.3.3.3, 3.12.3.3.4, 4.3.12.3.3.4, 3.12.3.3.5, 4.3.12.3.3.5, Appendix B
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		57000–NA–0063B	3.12.6.1, 4.3.12.6.1
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		57000–NA–0068B	4.3.12.9.1.4.1, 4.3.12.9.1.4.3, 4.3.12.9.1.4.4
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		57000–NA–0069A	3.2.1.3.4, 4.3.2.1.3.4
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		57000–NA–0070A	4.3.2.1.1.1, 4.3.2.1.1.2
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		57000–NA–0071A	4.3.2.1.2.1
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		57000–NA–0072A	4.3.2.1.2.2
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		57000–NA–0073A	4.3.2.1.3.1, 4.3.2.1.3.2
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		57000–NA–0075	3.2.2.3.2.1.2, 4.3.2.2.6.2.1.2
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		57000–NA–0076B	3.2.2.9, 4.3.2.2.9
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		57000–NA–0077	3.6.2.4, 4.3.6.2.4, 4.3.6.1.5
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		57000–NA–0078A	1.1, 2.1, 3.2.1.2.2, 3.2.3.3, 3.2.4.2, 3.2.4.5, 3.3.6.1.6.1, 3.3.6.1.6.2, 3.3.6.1.6.3, 3.6.1.5.3, 3.9.2.3, 3.9.3.1, 3.12.9.1.1, 3.12.9.2, 3.12.9.12, 4.3.2.3.3, 4.3.2.4.2, 4.3.2.4.5, 4.3.2.5.1.1, 4.3.2.5.1.2, 4.3.3.7.2.1, 4.3.3.7.3.1
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		57000–NA–0079A	3.2.5.3, 4.3.2.5.3
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		57000–NA–0081A	3.2.2.3

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0082A	3.12.9.1.2, 4.3.12.9.1.2, 3.12.9.1.3, 4.3.12.9.1.3
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		57000–NA–0083A	3.12.9.1.4.2, 4.3.12.9.1.4.2
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		57000–NA–0085A	3.2.2.6.1.1, 4.3.2.2.6.1.1
			FIGURE(S)
		57000–NA–0087	3.2.2.3–1
		57000–NA–0088	3.2.2.9–1
			PARAGRAPH(S)
		57000–NA–0089A	3.12.3.4, 4.3.12.3.4, Appendix A
			PARAGRAPH(S)
		57000–NA–0090	3.1.1.5, 4.3.1.1.5
			PARAGRAPH(S)
		57000–NA–0091A	3.2.5.5, 4.3.2.5.5
			PARAGRAPH(S)
		57000–NA–0092A	3.1.1.2, 4.3.1.1.2, 3.1.1.3, 4.3.1.1.3
			TABLE(S)
			3.1.1.3–2, 3.1.1.3–3
			PARAGRAPH(S)
		57000–NA–0093A	3.3.5.1.3, 4.3.3.5.1.3
			PARAGRAPH(S)
		57000–NA–0096A	3.9.3.2, 4.3.9.3.2
			PARAGRAPH(S)
		57000–NA–0097	3.3.5.1.4.1, 3.3.5.1.4.1.1, 3.3.5.1.4.1.2, 3.3.5.1.4.1.3, 3.3.5.1.4.1.4, 4.3.3.5.1.4.1, 4.3.3.5.1.4.1.1, 4.3.3.5.1.4.1.2, 4.3.3.5.1.4.1.3, 4.3.3.5.1.4.1.4, Appendix B
			PARAGRAPH(S)
		57000–NA–0098A	3.2.5.4, 4.3.2.5.4

SSCBD	ENTRY DATE	CHANGE	TABLE(S)
			3.2.5.4–1
		57000–NA–0099A	3.2.1.3.3–1
			PARAGRAPH(S)
		57000–NA–0100B	3.12.3.1.2, 4.3.12.3.1.2, 3.12.3.1.3, 4.3.12.3.1.3, 3.12.3.1.4, 4.3.12.3.1.4, 3.12.4.2.3, 4.3.12.4.2.3, 3.12.4.2.4, 4.3.12.4.2.4, 3.12.4.2.5.1, 4.3.12.4.2.5.1, 3.12.4.2.8.3, 4.3.12.4.2.8.3, 3.12.4.4.3, 4.3.12.4.4.3, 3.12.4.4.4, 4.3.12.4.4.4, 3.12.4.4.7, 4.3.12.4.4.7, 3.12.4.4.10, 4.3.12.4.4.10, 3.12.5.2.3, 4.3.12.5.2.3, 3.12.5.2.6, 4.3.12.5.2.6, 3.12.6.4.2, 4.3.12.6.4.2, 3.12.7.5.5, 4.3.12.7.5.5, 3.12.7.5.8, 4.3.12.7.5.8, 3.12.9.1.5, 4.3.12.9.1.5, 3.12.9.11, 4.3.12.9.11
			TABLE(S)
			3.12.6.4.2–1
			FIGURE(S)
			3.12.4.4.2–1, 3.12.6.4.2–1

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0101C	4.3.1.1, 3.1.1.6.1, 4.3.8.1, 3.12.1, 4.3.12.1, 3.12.2.3, 4.3.12.2.3, 3.12.4.3.3, 4.3.12.4.3.3, 3.12.4.3.4, 4.3.12.4.3.4, 3.12.4.3.5, 4.3.12.4.3.5, 3.12.4.3.10, 4.3.12.4.3.10, 3.12.4.3.11, 4.3.12.4.3.11, 3.12.4.3.13, 4.3.12.4.3.13, 3.12.4.3.15, 4.3.12.4.3.15, 3.12.4.4.1, 4.3.12.4.4.1, 3.12.4.4.5, 4.3.12.4.4.5, 3.12.4.4.11, 4.3.12.4.4.11, 3.12.4.4.12, 4.3.12.4.4.12, 3.12.5.2.1, 3.12.5.2.2, 4.3.12.5.2.2, 3.12.5.2.8, 4.3.12.5.2.8, 3.12.5.2.9, 4.3.12.5.2.9, 4.3.12.7, 4.3.12.7.1 3.12.7.5.3, 4.3.12.7.5.3, 3.12.7.5.6, 4.3.12.7.5.6, 3.12.7.5.7.1, 4.3.12.7.5.7.1, 3.12.7.5.9, 4.3.12.7.5.9, 3.12.7.5.10, 3.12.7.5.11, 4.3.12.7.5.11, 3.12.7.6, 4.3.12.7.6, 4.3.12.9.1.4, 3.12.9.1.4.5, 4.3.12.9.1.4.5, 3.12.9.1.5.1, 4.3.12.9.1.5.1, 3.12.9.9, 4.3.12.9.9, 3.12.9.10, 4.3.12.9.10, 3.12.9.12
			TABLE(S)
			3.1.1.6.1–1
			PARAGRAPH(S)
		57000–NA–0102	3.12.4.2.6, 4.3.12.4.2.6
			PARAGRAPH(S)
		57000–NA–0103B	3.12.2.2, 4.3.12.2.2, 4.3.12.3.1.2, 3.12.4.2.3, 4.3.12.4.2.3, 3.12.4.3.15, 4.3.12.4.3.15, 3.12.4.4.2, 4.3.12.9.2
			FIGURE(S)
		57000–NA–0103B	3.12.2.2–1, 3.12.4.4.2–1, 3.12.4.4.2–2

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0104C	3.12.4.2.1, 4.3.12.4.2.1, 3.12.4.2.8, 4.3.12.4.2.8, 3.12.7.2, 4.3.12.7.2, 3.12.7.5.2, 4.3.12.7.5.2, 3.12.7.5.3, 4.3.12.7.5.3, 3.12.7.5.4, 4.3.12.7.5.4, Appendix E
			PARAGRAPH(S)
		57000–NA–0105	3.2.2.6.1.1, 4.3.2.2.6.1.1
			PARAGRAPH(S)
		57000–NA–0106C	3.1.2.5, 3.2.2.6.1.1, 3.3.5.1.4.1, 3.12.7.5.12, 4.3.1.2.5, 4.3.2.1.3.4, 4.3.2.2.7.1, 4.3.2.3.1, 4.3.12.4.2.8.1, 4.3.12.6.4.4, 4.3.12.6.4.5
			FIGURE(S)
			3.12.4.4.2–2
			PARAGRAPH(S)
		57000–NA–0107A	3.12.3.4, 4.3.12.3.4, 3.12.8, 4.3.12.8
			TABLE(S)
			3.12.3.4–1, 3.12.3.4–2, 4.3.12.3.4–1
			PARAGRAPH(S)
		57000–NA–0108	3.10.2, 3.10.2.2.1, 3.10.2.2.2, 4.3.10.2.2.2, 3.10.2.2.2.1, 4.3.10.2.2.2.1, 3.10.2.2.2.2, 4.3.10.2.2.2.2, 3.10.3.4.1, 4.3.10.3.4.1, 3.10.3.4.2, 4.3.10..3.4.2
			FIGURE(S)
			3.10.3.4.1–1, 3.10.3.4.2–1
			PARAGRAPH(S)
001822A	28–APR–98	57000–NA–0109B	3.1.1.4, 3.1.1.4.1, 3.9.3, 3.9.3.4, 3.9.3.4.1, 3.9.3.4.2, 3.9.4, 4.3.1.1.3, 4.3.1.1.4, 4.3.1.1.4.1, 4.3.9.3.4, 4.3.9.3.4.1, 4.3.9.3.4.2, 4.3.9.4

SSCBD	ENTRY DATE	CHANGE	TABLE(S)
			3.9.3.4–1, 3.9.3.4–2, 3.9.4–1, 3.9.4–2
			FIGURE(S)
			3.9.3.4–1, 3.9.3.4–2, 3.9.3.4–3, 3.9.3.4–4, 3.9.4–1, 3.9.4–2, 3.9.4–3, 3.9.4–4
			PARAGRAPH(S)
		57000–NA–0111A	3.10.3.2, 3.12.4.1.1, 4.3.12.4.1.1
			PARAGRAPH(S)
		57000–NA–0112A	2.2, 3.1.1.2.1, 3.1.1.2.1.1, 3.1.1.2.1.2, 4.3.1.1.2.1, 4.3.1.1.2.1.1, 4.3.1.1.2.1.2
			FIGURE(S)
			3.1.1.2.1.1–1, 3.1.1.2.1.1–2, 3.1.1.2.1.1–3, 3.1.1.2.1.2–1, 3.1.1.2.1.2–2
			PARAGRAPH(S)
		57000–NA–0113	3.2.3.2, 4.3.2.3.2
			PARAGRAPH(S)
		57000–NA–0114D	3.3.6.1.3, 4.3.3.6.1.3
			PARAGRAPH(S)
		57000–NA–0115A	3.5.1.7, 4.3.5.1.7
			PARAGRAPH(S)
		57000–NA–0116C	4.3.1.1.3
			TABLE(S)
			3.1.1.3–1
			PARAGRAPH(S)
		57000–NA–0117A	3.12.5.2.1, 4.3.12.5.2.1
			PARAGRAPH(S)
		57000–NA–0119B	2.1
			PARAGRAPH(S)
		57000–NA–0120	3.12.9.1 4.3.2.5.4
			TABLE(S)
			3.12.9.1–1
			PARAGRAPH(S)
		57000–NA–0121B	1.4

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0122D	2.1, 3.12.7, 3.12.7.1, 3.12.7.2, 3.12.7.3, 3.12.7.4, 3.12.7.5, 3.12.7.5.1, 3.12.7.5.2, 3.12.7.5.3, 3.12.7.5.4, 3.12.7.5.5, 3.12.7.5.6, 3.12.7.5.7, 3.12.7.5.7.1, 3.12.7.5.8, 3.12.7.5.9, 3.12.7.5.10, 3.12.7.5.11, 3.12.7.5.12, 3.12.7.5.13, 3.12.7.6, 4.3.12.7, 4.3.12.7.1, 4.3.12.7.2, 4.3.12.7.3, 4.3.12.7.4, 4.3.12.7.5, 4.3.12.7.5.1, 4.3.12.7.5.2, 4.3.12.7.5.3, 4.3.12.7.5.4, 4.3.12.7.5.5, 4.3.12.7.5.6, 4.3.12.7.5.7, 4.3.12.7.5.7.1, 4.3.12.7.5.8, 4.3.12.7.5.9, 4.3.12.7.5.10, 4.3.12.7.5.11, 4.3.12.7.5.12, 4.3.12.7.5.13, 4.3.12.7.6, Appendix C (New)
			FIGURE(S)
			3.12.7.5.11–1
			PARAGRAPH(S)
		57000–NA–0123A	3.2.4, 4.3.2.4, 4.3.2.4.4, 4.3.2.4.6, 4.3.2.4.7, Appendix B
			PARAGRAPH(S)
		57000–NA–0126C	3.2.5.4, 3.12.9.1, 4.3.2.5.4, 4.3.2.5.5, 4.3.12.9.1
			PARAGRAPH(S)
		57000–NA–0127B	3.2.1.2.1, 3.2.1.2.2, 4.3.2.1.2.1, 4.3.2.1.2.2

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0128A	3.3.3, 3.3.4.1, 3.3.4.1.1.2, 3.3.4.1.2, 3.3.4.1.4, 3.3.4.2.1, 3.3.4.2.2, 3.3.5, 3.3.5.1.2, 3.3.5.1.3, 3.3.5.1.4, 3.3.5.1.4.1.2, 3.3.5.1.4.1.3, 3.3.5.1.4.1.4, 3.3.5.1.5, 3.3.5.1.6, 3.3.5.1.7, 3.3.5.1.8, 3.3.5.1.10, 3.3.5.1.11, 3.3.5.1.12, 3.3.5.2.1.2, 3.3.5.2.1.3, 3.3.5.2.3, 4.3.3.2.1, 4.3.3.2.2, 4.3.3.2.3, 4.3.3.3, 4.3.3.4.1, 4.3.3.4.1.1, 4.3.3.4.1.1.1, 4.3.3.4.1.1.2, 4.3.3.4.1.2, 4.3.3.4.1.3, 4.3.3.4.1.4, 4.3.3.4.2.1, 4.3.3.5, 4.3.3.5.1.1, 4.3.3.5.1.2, 4.3.3.5.1.3, 4.3.3.5.1.4, 4.3.3.5.1.4.1.2, 4.3.3.5.1.4.1.3, 4.3.3.5.1.4.1.4, 4.3.3.5.1.5, 4.3.3.5.1.6, 4.3.3.5.1.7, 4.3.3.5.1.8, 4.3.3.5.1.9, 4.3.3.5.1.10, 4.3.3.5.1.11, 4.3.3.5.1.12, 4.3.3.5.2.1.2, 4.3.3.5.2.1.3, 4.3.3.5.2.2
		57000–NA–0130	**PARAGRAPH(S)**
		57000–NA–0129A	3.1.1.6.1, 3.2.2.1
			TABLE(S)
			3.1.1.6.1–1
		57000–NA–0130	**PARAGRAPH(S)**
			3.2.5.1.1, 3.2.5.2, 3.3.10.1, 3.3.10.3, 4.3.2.2.8, 4.3.2.5.2, 4.3.3.10.1, 4.3.3.10.3, 4.3.12.9.1.2
			FIGURE(S)
			3.2.2.9–1, 4.3.2.2.8–2
		57000–NA–0131A	**PARAGRAPH(S)**
			3.2.3.1, 4.3.2.3.1
			FIGURE(S)
			3.2.3.1–1
		57000–NA–0133A	**PARAGRAPH(S)**
			3.5.1.15, 4.3.5.1.15

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0135H	3.1.1.4, 3.1.1.7, 3.1.1.7.1, 3.1.1.7.2, 3.1.1.7.3, 3.1.1.7.4, 3.1.1.7.5, 3.12.4.1, 4.3.1.1.4, 4.3.1.1.7, 4.3.1.1.7.1, 4.3.1.1.7.2, 4.3.1.1.7.3, 4.3.1.1.7.4, 4.3.1.1.7.5, 4.3.12.4.1, Appendix B
			FIGURE(S)
			3.1.1.4–1, 3.1.1.7.2–1, 3.1.1.7.3–1, 3.1.1.7.5–1
		57000–NA–0136C	**PARAGRAPH(S)**
			2.1, 3.3.8, 3.12.11, 4.3.3.8, 4.3.12.11
		57000–NA–0137	3.2.6.2.2, 3.2.6.2.4, 3.2.6.3, 4.3.2.6.2.2, 4.3.2.6.2.4, 4.3.2.6.3
			TABLE(S)
			3.2.6.2.4–1
			FIGURE(S)
			3.2.6.2.2–1
			PARAGRAPH(S)
002533	21–JUL–99	57000–NA–0132C	3.6.1.5, 3.6.1.5.1, 3.12.3.1.6, 4.3.6.1.5, 4.3.6.1.5.1, 4.3.12.3.1.6
			TABLE(S)
			2.1, 4.3.6.1.5–1, Appendix A, Appendix B, Appendix D1, Appendix D2, Appendix D3, Appendix D4, Appendix D5, Appendix D6
			PARAGRAPH(S)
		57000–NA–0139B	3.2.5.2, 3.2.5.3, 4.3.2.5.3
			PARAGRAPH(S)
		57000–NA–0140A	3.12.4.3.3, 4.3.12.4.3.3
			TABLE(S)
		57000–NA–0141	3.12.3.4–1
			PARAGRAPH(S)
		57000–NA–0143A	3.2.5.4, 3.2.5.5, 4.3.2.5.4, 4.3.2.5.5

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0146A	2.1, 3.3.5, 4.3.3.5, 4.3.3.5.1.9, 4.3.3.5.1.10, 4.3.3.5.1.11, 4.3.3.5.1.12, 4.3.3.5.2.2, 3.3.5.2.4, 4.3.3.5.2.4
			PARAGRAPH(S)
		57000–NA–0147A	3.5.1.3, 4.3.5.1.3
			PARAGRAPH(S)
		57000–NA–0149	3.2.4.9, 4.3.2.4.9
			PARAGRAPH(S)
		57000–NA–0150C	3.5.1.13, 4.3.5.1.13
			TABLE(S)
			3.5.1.13–1
			PARAGRAPH(S)
		57000–NA–0152A	3.2.2.6.2.1.1, 3.2.6.2.5, 4.3.2.6.2.1.1
			PARAGRAPH(S)
		57000–NA–0153	3.2.2.6.1.1
			TABLE(S)
		57000–NA–0154	3.9.3.4–1
			PARAGRAPH(S)
		57000–NA–0155	3.1.1.3
			TABLE(S)
			3.1.1.3–2, 3.1.1.3–3, 3.1.1.3–4
			PARAGRAPH(S)
		57000–NA–0156A	3.5.1.11
			PARAGRAPH(S)
		57000–NA–0157A	3.9.1.3, 4.3.9.1.3
			FIGURE(S)
			3.9.1.3–1
			TABLE(S)
			3.9.4–1
			PARAGRAPH(S)
		57000–NA–0158	3.5.1.9
			PARAGRAPH(S)
		57000–NA–0159	3.7.1.4

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0160	2.1, 3.1.3
			PARAGRAPH(S)
		57000–NA–0162	3.2.1.4, 3.2.6.1, 4.3.2.1.4, 4.3.2.6.1
			PARAGRAPH(S)
		57000–NA–0163A	3.6.1.2, 4.3.6.1.2
			PARAGRAPH(S)
		57000–NA–0164B	4.3.12.7.1, 4.3.12.7.5.9, C.2, C.3.4, C.3.5.1, C3.5.2, C.3.5.3, C.3.5.4, C.3.5.5.2, C.3.5.6, C.3.5.7, C.3.5.8, C.3.5.9, C.3.5.10.2, C.3.5.11, C.3.6
			FIGURE(S)
			C.1–1, C.3.5.3–2, C.3.5.4.2.1–1, C.3.5.8–1
			PARAGRAPH(S)
		57000–NA–0165A	3.2.5.2, 3.3.10.1
			PARAGRAPH(S)
		57000–NA–0166B	3.3.7.2.1, 3.3.7.2.1.1, 4.3.3.7.2.1, 4.3.3.7.2.1.1
			PARAGRAPH(S)
		57000–NA–0167	3.3.7.3.1, 3.3.7.3.2
			PARAGRAPH(S)
		57000–NA–0168B	3.1.1.3, 3.1.1.4, 3.2.1, 3.6.1, 3.6.1.1., 3.6.1.2, 3.6.1.5, 3.6.2, 3.6.2.1, 3.6.2.2., 3.6.2.3, 3.6.2.4, 3.7.1.5, 3.7.2.1, 3.7.2.3, 3.7.2.5, 3.7.3.1, 3.7.3.3, 3.7.3.5, 3.7.4.1, 3.7.4.3, 3.7.4.5, 3.12.4.4.13, 4.3.5.1.9, 4.3.12.4.4.13
			TABLE(S)
			3.1.1.3–1, 3.1.1.3–3, 3.1.1.6.1–1, 3.2.1–1, 3.9.4–1
			PARAGRAPH(S)
		57000–NA–0170	3.2.2.10, 3.2.4.4, 4.3.2.2.10
			PARAGRAPH(S)
		57000–NA–0174A	3.3.5.2.1.4, 4.3.3.5.2.1.4

SSCBD	ENTRY DATE	CHANGE	FIGURE(S)
			3.3.5.2.1.4–1
			TABLE(S)
			3.3.5.2.1.4–1
			PARAGRAPH(S)
		57000–NA–0177A	4.3.2.4.8
			PARAGRAPH(S)
003132F	01–NOV–00	57000–NA–0151H	4.3.5.1.3
			TABLE(S)
			E–2
			PARAGRAPH(S)
		57000–NA–0161C	3.2.4.6, 3.2.4.7, 4.3.2.4.6, 4.3.2.4.7
			TABLE(S)
		57000–NA–0179	3.3.10.1–1
			PARAGRAPH(S)
		57000–NA–0180	4.3.3.8.1
			PARAGRAPH(S)
		57000–NA–0181C	3.3.6.1.2, 3.3.6.1.3, 4.3.3.6.1.2, 4.3.3.6.1.3
			PARAGRAPH(S)
		57000–NA–0182	3.3.7.2.3, 3.3.7.3.1, 3.3.7.3.2, 4.3.3.7.2.3
			TABLE(S)
		57000–NA–0183A	3.12.3.4–1
			PARAGRAPHS(S)
		57000–NA–0184A	3.6.1.6, 4.3.6.1.6
			PARAGRAPHS(S)
		57000–NA–0185A	Appendix D
			TABLE(S)
			D–1, D–2
			PARAGRAPHS(S)
		57000–NA–0189	3.5.1.4, 3.5.1.5, 3.5.1.12, 3.5.1.14, 3.5.1.16, 3.5.1.17, 4.3.5.1.4, 4.3.5.1.12, 4.3.5.1.14, 4.3.5.1.16, 4.3.5.1.17

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		57000–NA–0191A	3.1.1.6.1–1
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		57000–NA–0193B	3.7.5, 4.3.7.5
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		57000–NA–0194	3.7.1.4, 3.7.2.4, 3.7.3.4, 3.7.4.4
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		57000–NA–0195E	3.4.1.1, 4.3.4.1.1
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		57000–NA–0202	3.6.2.2, 4.3.6.2.2
			PARAGRAPH(S)
		57000–ES–0001A	1.5, 2.1
			PARAGRAPH(S)
		57000–ND–0003C	3.4.1.3.1, 3.4.1.3.2, 3.4.1.3.3, 3.4.1.3.4, 4.3.4.1.3.1, 4.3.4.1.3.2, 4.3.4.1.3.3, 4.3.4.1.3.4
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003970	24–APR–01	57000–NA–0205A	3.12.3.3.1.C, 4.3.12.3.3.1.C
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		57000–NA–0203	1.1, 2.1, 3.3.1, 3.3.4.1.1.1, 3.3.4.1.1.2, 3.3.4.1.2, 3.3.4.1.3, 3.3.4.1.4, 3.3.4.2, 3.3.4.2.1, 3.3.4.2.2, 3.3.6.1.1, Appendix A
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		57000–NA–0208	3.12.3.3.2–1
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		57000–NA–0222	3.2.5.1.1
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		57000–NA–0235A	3.2.5.2, 3.3.10.1, 4.3.2.5.2, 4.3.3.10.1
			TABLE(S)
			3.2.5.2–1
			TABLE(S)
005833	01–FEB–02	57000–NA–0211B	3.12.3.4–1
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		57000–NA–0215	3.4.1.4
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		57000–NA–0216	2.1, 3.1.3
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		57000–NA–0218	4.3.1.1.7.B
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		57000–NA–0219	3.3.5.1.9
			PARAGRAPH(S)
		57000–NA–0231	3.1.1.1.C, 2.1
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		57000–NA–0233D	3.2.2.12, 4.3.2.2.12
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		57000–NA–0234	3.3.8.1.E, 3.3.9.2.2.A
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		57000–NA–0250A	3.2.2.9, 4.3.2.2.9

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		57000–NA–0251C	3.1.2.4
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			3.9.4–2, 3.9.4–3, 3.9.4–4
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003664R1	07–JUN–02	57000–NA–0110H	3.1.2, 3.1.2.1, 3.1.2.2, 3.1.2.3, 3.1.2.4, 3.1.2.5, 4.3.1.2, 4.3.1.2.1, 4.3.1.2.2, 4.3.1.2.3, 4.3.1.2.4, 4.3.1.2.5, Appendix B
			TABLE(S)
			3.1.2.2–1, 3.1.2.2–2, 3.1.2.5–1
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			PARAGRAPH(S)
005717	29–JUL–02	57000–NA–0200B	2.0, 2.1, 2.2
			PARAGRAPH(S)
		57000–NA–0201	3.3.5.1.3, 4.3.3.5.1.3, Appendix A
			PARAGRAPH(S)
		57000–NA–0209C	3.10.2.1.2, 4.3.10.2.1.2
			PARAGRAPH(S)
		57000–NA–0210	4.3.2.2.6.2.1.1, 4.3.2.6.2.1.1
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		57000–NA–0227A	4.3.12.9.1.3, 4.3.12.9.1.3.1, 4.3.12.9.1.3.2, 4.3.12.9.1.3.3, 4.3.12.9.1.3.4, 4.3.12.9.1.3.5, 4.3.12.9.1.4, 4.3.12.9.1.4.1, 4.3.12.9.1.4.2, 4.3.12.9.12.4.3, 4.3.12.9.1.4.4, 4.3.12.9.1.4.5,
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		57000–NA–0228	4.3.2.4.10, 4.3.3.4.1.4, 4.3.7.1.5, 4.3.7.2.5, 4.3.7.3.5, Appendix A
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		57000–NA–0229	3.3.5.1.4
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		57000–NA–0232	3.3.5.2.3, 4.3.3.5.2.3
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			PARAGRAPH(S)
005244R2	22–NOV–02	57000–NA–0214C	3.12.6.4.1, 4.3.12.6.4.1
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			3.12.6.4.1–1
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			3.12.6.4.1–1
			PARAGRAPH(S)
		57000–NA–0217A	3.5.1.10, 3.5.1.17, 4.3.5.1.17
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			PARAGRAPH(S)
		57000–NA–0220A	3.7.1.1, 3.7.2.1, 3.7.3.1, 3.7.4.1, 4.3.7.1.1, 4.3.7.2.1, 4.3.7.3.1, 4.3.7.4.1
			PARAGRAPH(S)
		57000–NA–0224	4.3.2.2.7.1, 4.3.2.2.7.2
			PARAGRAPH(S)
		57000–NA–0225A	3.2.2.4, 4.3.2.2.4
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			PARAGRAPH(S)
		57000–NA–0207	3.7.1.4, 3.7.2.4, 3.7.3.4, 3.7.4.4, 4.3.7, 4.3.7.1, 4.3.7.1.2, 4.3.7.1.4, 4.3.7.1.5, 4.3.7.2, 4.3.7.2.2, 4.3.7.2.4, 4.3.7.2.5, 4.3.7.3, 4.3.7.3.2, 4.3.7.3.4, 4.3.7.3.5, 4.3.7.4, 4.3.7.4.2, 4.3.7.4.4, 4.3.7.4.5, 4.3.7.6, Appendix A
			PARAGRAPH(S)
		57000–NA–0212D	2.2, 3.1.2.6, 3.1.2.6.1, 3.1.2.6.2, 4.3.1.2.6, 4.3.1.2.6.1, 4.3.1.2.6.2 Appendix A
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			PARAGRAPH(S)
		57000–NA–0226A	4.3.1.1.7.5
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		57000–NA–0230A	3.1.1.4.1, 4.3.1.1.4.1
			PARAGRAPH(S)
		57000–NA–0240G	4.3.12.7, Appendix C–Table of Contents, C.1, C.2, C.3, C.3.1, C.3.2, C.3.5.1, C.3.5.3, C.3.5.4.1, C.3.5.4.2, C.3.5.4.2.1, C.3.5.4.2, C.3.5.4.2.1, C.3.5.4.2.2, C.3.5.4.2.3, C.3.5.5, C.3.5.6, C.3.5.7, C.3.5.9, C.3.5.10.2, C.3.5.11, C.3.6, C.3.7
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			PARAGRAPH(S)
		57000–NA–0246A	3.2.2.1, 4.3.2.2.1,
			PARAGRAPH(S)
005453R1	06–DEC–02	57000–NA–0134F	3.5.1.2, 4.3.5.1.2
			PARAGRAPH(S)
		57000–NA–0175C	3.11.2, 3.11.2.1, 3.11.2.2, 3.11.2.3, 4.3.11.2, 4.3.11.2.1, 4.3.11.2.2, 4.3.11.2.3
			PARAGRAPH(S)
006251R2	06–DEC–02	57000–NA–0148B	3.12.3.3.1, 3.12.3.3.2, 4.3.12.3.3.1, 4.3.12.3.3.2
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			4.3.12.3.3.1–1
			PARAGRAPH(S)
		57000–NA–0176H	3.2.2.5, 3.2.2.5.1, 3.2.2.5.2, 4.3.2.2.5, 4.3.2.2.5.1, 4.3.2.2.5.2

SSCBD	ENTRY DATE	CHANGE	TABLE(S)
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			PARAGRAPH(S)
		57000–NA–0238A	3.2.1.3.1, 3.2.1.3.2
			FIGURE(S)
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			PARAGRAPH(S)
		57000–NA–0241D	3.3.5.2.1.4, 3.3.6.1.4, 3.3.6.1.6, 3.3.6.1.6.1, 3.3.6.1.6.2, 3.3.6.1.6.3, 4.3.3.5.1.4, 4.3.3.5.1.9, 4.3.3.5.2.1.4, 4.3.3.6.1.4, 4.3.3.6.1.6.1, 4.3.3.6.1.6.2, 4.3.3.6.1.6.3
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		57000–NA–0242	3.3.10.2.3, 4.3.3.10.2.3
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		57000–NA–0255	3.2.2.11, 4.3.2.2.11
			TABLE(S)
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			PARAGRAPH(S)
		57000–NA–0258A	3.1.1.4, 4.3.1.1.4
			PARAGRAPH(S)
		57000–NA–0265	3.1.1.4.1, 4.3.1.1.4.1

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006892R2		57000–NA–0197D	3.10.1, 3.10.2, 3.10.2.1.1, 3.10.2.2.1, 3.10.2.2.2.1, 3.10.2.2.2.2, 4.3.10, 4.3.10.1, 4.3.10.2, 4.3.10.2.1.1, 4.3.10.2.2.2.1, 4.3.10.2.2.2.2, Appendix B
			PARAGRAPH(S)
		57000–NA–0253D	3.3.7.1, 3.3.7.1.1, 3.3.7.1.1.1, 3.3.7.1.1.2, 3.3.7.1.1.3, 3.3.7.1.2, 3.3.7.1.2.1, 3.3.7.1.2.2, 3.3.7.2.1, 3.3.7.2.1.1, 3.3.7.2.2, 3.3.7.3.1, 3.3.7.3.2, 3.3.7.4, 3.3.7.5, 3.3.7.6, 3.3.7.7, 3.3.7.8, 4.3.3.7.1, 4.3.3.7.1.1, 4.3.3.7.1.1.1, 4.3.3.7.1.1.2, 4.3.3.7.1.1.3, 4.3.3.7.1.2, 4.3.3.7.1.2.1, 4.3.3.7.1.2.2, 4.3.3.7.2.1, 4.3.3.7.2.1.1, 4.3.3.7.2.2, 4.3.3.7.3.1, 4.3.3.7.3.2, 4.3.3.7.5, 4.3.3.7.6, 4.3.3.7.8, Appendix A
			PARAGRAPH(S)
		57000–NA–0254B	3.2.5.4, 3.2.5.5, 3.12.9.1, 4.3.2.5.4, 4.3.2.5.5, 4.3.12.9.1
			TABLE(S)
			3.2.5.4–1
			PARAGRAPH(S)
		57000–NA–0260B	3.3.5.2.2, 4.3.3.5.2.2
			PARAGRAPH(S)
		57000–NA–0267	3.10.2.2.2.2
			PARAGRAPH(S)
		57000–NA–0269B	3.2.2.7.1
			FIGURE(S)
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		57000–NA–0272A	3.1.1.7.2–2, 3.1.1.7.5–1, 3.1.1.7.5–2, 3.1.1.7.5–3

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57000–NA–0273A	3.1.1.5, 3.12.9.13, 3.12.9.14, 4.3.11.5, 4.3.12.9.13, 4.3.12.9.14
	PARAGRAPH(S)
57000–NA–0274A	4.3.1.1.1, 4.3.1.1.4
	PARAGRAPH(S)
57000–NA–0276E	3.5.1.5, 3.6.1.5.3, 3.6.1.5, 3.7.1.3, 3.7.2.3, 3.7.3.3, 3.7.4.3, 3.7.6, 4.3.5.1.10, 4.3.6.1.5, 4.3.6.1.5.3, 4.3.7.1.3, 4.3.7.2.3, 4.3.7.3.3, 4.3.7.4.3, 4.3.7.6
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57000–NA–0277D	3.2.4.6, 3.2.4.7, 4.3.2.2.6.1.1, 4.3.2.4.6, 4.3.2.4.7
	PARAGRAPH(S)
57000–NA–0278D	3.12.3.3, 4.3.12.3.3.1, 4.3.12.3.3.2
	PARAGRAPH(S)
57000–NA–0279	3.11.1, 3.11.1.1, 4.3.11.1, 4.3.11.1.1
	PARAGRAPH(S)
57000–NA–0285	3.10.4, 4.3.10.4
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57000–NA–0287B	4.3.12, Appendix F
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APPENDIX

TABLES

TABLES (Continued)

FIGURES

FIGURES (Continued)

1.0 INTRODUCTION

1.1 PURPOSE

This Interface Requirements Document (IRD) is the principle source interface design requirements document. It will be complied with in order to certify a pressurized payload for integration into applicable ISS modules. These include United States Laboratory (USL), Attached Pressurized Module (APM), Japanese Experiment Module (JEM), Centrifuge Accommodations Module (CAM), and Multi-Purpose Logistics Module (MPLM). NSTS 1700.7, ISS Addendum and NSTS 18798 provides the safety requirements for payload design.

1.2 SCOPE

The physical, functional, and environmental design requirements associated with payload safety and interface compatibility are included herein. The requirements defined in this document apply to ground handling and processing, transportation and on–orbit phases of the pressurized payload operation. Transportation requirements are specific to the MPLM. The reader is referred to NSTS 21000–IDD–MDK for requirements related to transportation in the Shuttle middeck area. On-orbit requirements apply to all the payloads in the USL, APM, JEM, MPLM, and CAM. The interface requirements defined herein primarily address the module to integrated rack interface. Subrack payloads should design their hardware compatible with the integrated rack or facility they will be transported and operated within.

1.3 USE

This document levies design interface and verification requirements on ISS pressurized payload developers or integrators. These requirements are allocated to a integrated rack or pressurized payload through the applicability matrix in the unique payload Interface Control Document. The unique payload ICD defines and controls the design of the interfaces between the ISS and the pressurized payload, including module unique interfaces, constraints, definition of selectable parameters, and stage unique constraints. This document acts as a guideline to establish commonality with the respect to analytical approaches, models, test methods and tools, technical data and definitions for integrated analysis. Engineering units and conversions will be per ASTM E380–86, Standard For Metric Practice.

1.4 EXCEPTIONS

The Unique Pressurized Payload Hardware ICD documents the payload implementation of the ICD blank book requirements. The Unique ICD is used to determine if the hardware design remains within the interface design parameters defined by this document. Limits of the ICD are established in a conservative manner to minimize individual payload and mixed cargo analyses.

Any exception to requirements, capabilities, or services defined in this IRD shall be documented in a unique section of the derived ICD and evaluated to ensure that the stated condition is controlled. This unique section will document the specific requirement excepted, a description of the existing condition, and a rationale for acceptance. It will also include the necessary PIRN forms and other documentation required by the ISS Program. Exceptions are classified as either exceedances, deviations, or waivers, as defined below.

Definitions:

EXCEPTION

The general term used to identify any payload–proposed departure from specified requirements or interfaces. An exception is further classified as an exceedance, deviation or waiver per the descriptions provided below.

EXCEEDANCE

An Exceedance is a condition that does not comply with a stated IRD requirement or ICD template interface, which is identified prior to baselining the payload–unique ICD. It exceeds the defined payload limits but when combined with the remaining payload complement the module/ISS limits are not exceeded, or it does not impact the performance of the remaining payload complement, and it does not impact vehicle subsystems performance. The exception can be shown to be acceptable within the framework of the standard element level analysis cycle without any unique analysis or controls.

An Exceedance can be approved by the PTR and documented in the payload–unique ICD. Exceedances do not require approval by Control Board.

For Example: One of the requirements is that the delta–T on the Moderate Temperature Loop should be at least 35°F. If “Payload X” wishes to have a delta–T of 32°F, this would be classified as an exceedance. It does not exceed vehicle limits or affect safety; it only influences the efficiency of the use of the Moderate Temperature Loop.

DEVIATION

A Deviation is a non–compliance to an IRD requirement or ICD Template interface, which is identified prior to baselining the payload–unique ICD. It is different from an Exceedance in that the defined exception exceeds module/ISS limits. Additional analysis outside the scope of the standard element analysis cycle or unique operational guidelines or constraints may be needed to approve the exception. Deviations must be approved by a Control Board.

For Example: One of the requirements is that the maximum return temperature of the Moderate Temperature Loop should be 120°F. If “Payload Y” wishes to have a return temperature of 123°F, and their ICD has not been baselined, this would be classified as a Deviation. The vehicle is designed to accommodate return temperatures of 120°F or less, and special analysis must be done to determine if the vehicle can accommodate this, or if operational constraints will be required.

WAIVER

A Waiver is a condition found in non–compliance to an IRD requirement or to the baselined payload–unique ICD, which is identified after baselining the payload–unique ICD. Typically this will occur as a result of the final as–built hardware verification program. It may require additional analysis outside of the scope of the standard element analysis cycle or unique operational guidelines or constraints to approve the exception. Waivers must be approved by a Control Board.

For Example: One of the requirements is that the continuous acoustic noise must not exceed NC40. “Payload Z” has already baselined their ICD, and recent testing of the flight hardware shows that their continuous noise level is NC45. Additional evaluation will be required to determine if this can be accepted, and it may result in operational constraints.

Note:

Exceedances, deviations, and waiver to the requirements in this document require the use of the formal Exception Process as detailed in section 5 of SSP 57001.

1.5 CONTROL AND MAINTENANCE

This IRD is controlled, through the Multilateral Payload Implementation Control Board (MPICB) in accordance with the procedures defined in SSP 50123, Volume 1, Configuration Management Handbook. Changes to this IRD are approved as a result of discussions of proposed changes reviewed by the various partners. Following approval, NASA maintains the base–lined IRD, including the incorporation of approved changes, which NASA Configuration Management Office (CMO) will release and distribute in accordance with the procedures defined in SSP 50123, Configuration Management Handbook (Volume 1).

2.0 DOCUMENTATION

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. Specific date and revision number of documents under control of the Space Station Control Board can be found in SSP 50257, Program Control Document Index or SSP 50258, Prime Control Document Index.

The documents in this paragraph form a part of this specification to the extent specified herein. In the event of a conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

2.1 APPLICABLE DOCUMENTS

DOCUMENT NO.	TITLE
CCSDS 301.0–B–2	CCSDS Time Code Format
CCSDS 701.0-B-2	Advanced Orbiting Systems, Network and Data Links: Architectural Specification, Blue Book
220G07455	Upper Structure Assembly
220G07470	MSFC Base Assembly
220G07475	SSPF Base Assembly
220G07500	Rack Shipping Containers
683-50243-4	Rack, Equipment, U.S. Standard–Assy
683–10007	Fire Detection Assembly
683–17103	Fluid System Servicer (FSS) Interface Definition Drawings
D684–10056–01	International Space Station Program, Prime Contractor Software Standards and Procedures Specification
EIA–RS–170	Electrical Performance Standards for Television Studio Facilities
EIA/TIA 250	Electrical Performance for Television Relay Facility
FED–STD–595	Federal Standard Colors Used in Government Procurement
ISO/IEC 8802-3	Carrier Sense Multiple Access With Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
JSC 27199	End Item Specification for the International Space Station Portable Utility Light
JSC 27260	Decal Process Document and Catalog
JSC 27337	Project Technical Requirements for the PCS

DOCUMENT NO.	TITLE
MA2–95–048	Thermal Limits for Intravehicular Activity
MA2–97–093	Crew Mating/Demating of Powered Connectors
MIL–HDBK–1553	Digital Time Division Command/Response Multiplex Data Bus Handbook
MIL–STD–462	EMI Characteristics, Measurement of
MIL–STD–1553B	Digital Time Division Command/Response Multiplex Data Bus
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) Document
MSFC–SPEC–250	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification for Document
MSFC–STD–275	Marking of Electrical Ground Support Equipment, Front Panels, and Rack Title Plates
NTC Report No. 7	Video Facility Testing Technical Performance Objectives (NTC)
NSTS/ISS 13830	Payload Safety Review and Data Submittal Requirements For Payloads Using the Space Shuttle and International Space Station
NSTS 1700.7 ISS Addendum	Safety Policy and Requirements for Payloads Using the International Space Station
NSTS/ISS 18798	Interpretations of NSTS/ISS Payload Safety Requirements
SDD32100397	Decal, Fire Hole
SED33108703	Desk Top Plate Assy, Inflight Computer
SED39126010	Assembly, DC Power Supply PGSC 486
SEG33107631	Bracket Assy, Multi–Use
SN–C–0005	NSTS Contamination Control Requirements Manual
SSP 30233	Space Station Requirements for Material and Processes
SSP 30237	Space Station Requirements for Electromagnetic Emission and Susceptibility Requirements
SSP 30238	Space Station Electromagnetic Techniques
SSP 30240	Space Station Grounding Requirements

DOCUMENT NO.	TITLE
SSP 30242	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
SSP 30243	Space Station Requirements for Electromagnetic Compatibility
SSP 30245	Space Station Electrical Bonding Requirements
SSP 30257:004	Space Station Program Intravehicular Activity Restraints and Mobility Aids Standard ICD
SSP 30262:013	Smoke Detector Assembly Standard ICD
SSP 30312	Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan For Space Station Program
SSP 30426	External Contamination Control Requirements
SSP 30482 (V1)	Electric Power Specifications and Standards, Vol. 1: EPS Performance Specifications
SSP 30512	Ionizing Radiation Design Environment
SSP 30573	SSP Fluid Procurement and Use Control Specification
SSP 41002	International Standard Payload Rack to NASA/NASDA Modules Interface Control Document
SSP 41017	Rack to Multi–Purpose Logistics Module Interface Control Document (ICD) Part 1 and Part 2
SSP 41175-02	Software ICD Part 1 Station Management and Control to ISS Book 2 General Interface Software Interfaces Requirement
SSP 50005	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T) Document
SSP 50184	High Rate Data Link Physical Media, Physical Signaling & Protocol Specifications
SSP 50313	Display and Graphical Commonality Standard

DOCUMENT NO.	TITLE
SSP 52005	Payload Flight Equipment Requirements and Guidelines for Safety–Critical Structures
SSP 52050	Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station.
SSP 57001	Pressurized Payload Hardware ICD
SSP 57002	Pressurized Payload Software ICD
SSQ 21635	Connectors and Accessories, Electrical, Rectangular, Rack and Panel
SSQ 21654	Cable, Single Fiber, Multitude, Space Quality, General Specification for Document
SSQ 21655	Cable, Electrical, MIL-STD-1553 DataBus, Space Quality, General
TM 102179	Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits
TM–9A–038	Protection of Payload Electrical Power Circuits

2.2 REFERENCE DOCUMENTS

ANSI S1.4	Specification for Sound Level Meters Amendment S1.4A–1985 ASA 37 R(1994)
ANSI S1.11	Specification for Octave–Band and Fractional–Octave–Band Analog and Digital Filters; ASA 65–1986 R(1993)
ANSI S12.12–1992	Engineering Method for the Determination of Sound Power Levels of Noise Sources Using Sound Intensity ASSA 104
ANSI S12.23	Method for the Designation of Sound Power Emitted by Machinery and Equipment
ANSI S12.23 1996	Method for the Designation of Sound Power Emitted by Machinery and Equipment
ANSI S12.31	Precision Methods for Determination of Sound Power Levels of Broad–Band Noise Sources in Reverberation Rooms
ANSI S12.32	Precision Methods for the Determination of Sound Power Levels of Discrete–Frequency and Narrow–Band Noise Sources in Reverberation Rooms
ANSI S12.33	Engineering Methods for the Determination of Sound Power Levels of Noise Sources in a Special Reverberation Test Room
ANSI S12.34	Engineering Methods for the Determination Sound Power Levels of Noise Sources for Essentially Free–Field Conditions Over a Reflecting Plane

ANSI–S12.35	Precision Methods for the Determination of Sound Power Levels of Noise Sources in Anechoic and Hemi–Anechoic Rooms
ANSI–S12.36	Survey Methods for the Determination of Sound Power Levels of Noise Sources
ANSI X3.255	Fibre Distributed Data Interface (FDDI) – Abstract Test Suite for FDDI Physical Medium Dependent Conformance Testing (PMD ATS)
ASTM E380–86	Standard Practice for Use of the International System of Units (SI) (modernized Metric System)
ICD–A–21378	SSP DEAP TO ISSP HAS/CHEK GSE Interfaces
ICD–A–21379	ISS Payload/GSE Ground Operations Envelope ICD
JSC 26557	International Space Station On–Orbit Assembly, Modeling, and Mass Properties Databook
MIL–STD–461	Electromagnetic Emission and Susceptibility Requirements for Control of Electromagnetic Interference
MSFC–STD–531	High Voltage Design Criteria
NHB 8060.1	Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion
NSTS 21000–IDD–MDK	Middeck Payloads Interface Definition Document for Middeck Accommodations
SAIC–TN–9550	Ionizing Radiation Dose Estimates for International Space Station Alpha using the CADrays 3–D Mass Model
SSP 30219	Space Station Reference Coordinate Systems
SSP 41000	System Specification for the International Space Station
SSP 50007	Space Station Inventory Management System Label Specification
SSP 50014	International Space Station Utility Coding Specification
SSP 50053	ASI Flight Hardware to Launch and Landing Site ICD
SSP 50257	Program Control Document Index
SSP 50258	Prime Control Document Index
SSP 50467	ISS Cargo Stowage Technical Manual: Pressurized Volume

3.0 PAYLOAD INTERFACE REQUIREMENTS AND GUIDANCE

The requirements contained in this section will be complied with in order to certify a payload for integration into the applicable ISS modules. This section is divided by the following disciplines: Structural and Mechanical, Electrical, Command and Data Handling, Audio/Video, Thermal Control, Vacuum Exhaust and Vacuum Resource, Gases, Payload Support Services, Environment, Fire Protection, Material and Parts, Human Factors. Unless otherwise specified as USL, JEM, APM, MPLM, or CAM, a requirement applies to all modules.

3.1 STRUCTURAL/MECHANICAL, AND MICROGRAVITY AND STOWAGE INTERFACE REQUIREMENTS

3.1.1 STRUCTURAL/MECHANICAL

3.1.1.1 GSE INTERFACES

A. Integrated racks shall interface to the KSC GSE Rack Insertion Device in accordance with SSP 41017 Part 1, paragraph 3.2.1.1.2 Static Envelope, 3.2.1.4.3 Interface Loads, and SSP 41017 Part 2, paragraph 3.3.2 Upper Attachment Interfaces and 3.3.3 Ground Handling Attachment Interfaces.

B. Integrated racks shall interface to Rack Shipping Containers in accordance with the Teledyne Brown Engineering (TBE) as-built drawing 220G07500.

C. Integrated racks shall interface to Rack Handling Adapters (RHA) in accordance with the following TBE as-built drawings: 220G07455 Upper Structure Assembly, 220G07470 MSFC Base Assembly, and 220G07475 SSPF Base Assembly.

D. Integrated racks shall be limited to ground transportation accelerations of 80% of flight accelerations defined by SSP 41017 Part 1, paragraph 3.2.1.4.2.

3.1.1.2 MPLM INTERFACES

A. Integrated racks shall interface to the MPLM structural attach points in accordance with SSP 41017 Part 2, paragraph 3.1.1.

B. Integrated racks shall maintain positive margins of safety for MPLM depress rates of 890 Pa/second (7.75 psi/minute) and repress rates of 800 Pa/second (6.96 psi/minute).

C. Deleted.

D. Deleted.

E. Integrated racks shall be limited to producing interface attach point loads less than or equal to those identified by SSP 41017 Part 1, paragraph 3.2.1.4.3, based upon an acceleration environment as defined in SSP 41017 Part 1, paragraph 3.2.1.4.2.

3.1.1.2.1 MPLM LATE/EARLY ACCESS REQUIREMENTS

The requirements contained in this section define and control the ISS MPLM late/early access for payloads and associated GSE. Additional program provided late/early access GSE data is referenced in SSP 50053, ASI Flight Hardware to Launch and Landing Site ICD; ICD–A–21378, SSP DEAP to ISSP HAS / CHEK GSE Interfaces; ICD–A–21379, ISS Payload / GSE Ground Operations Envelope.

Late Access is defined as cargo integration during pre–launch activities with the orbiter in the vertical position. Late Access for stowage of conditioned samples inside the MPLM is completed by L–88 hours, and is followed by MPLM late access GSE removal.

Early Access is defined as cargo deintegration during post–landing activities with the orbiter in the horizontal position. Payload activities will begin approximately 96 hours after landing / return (R+96).

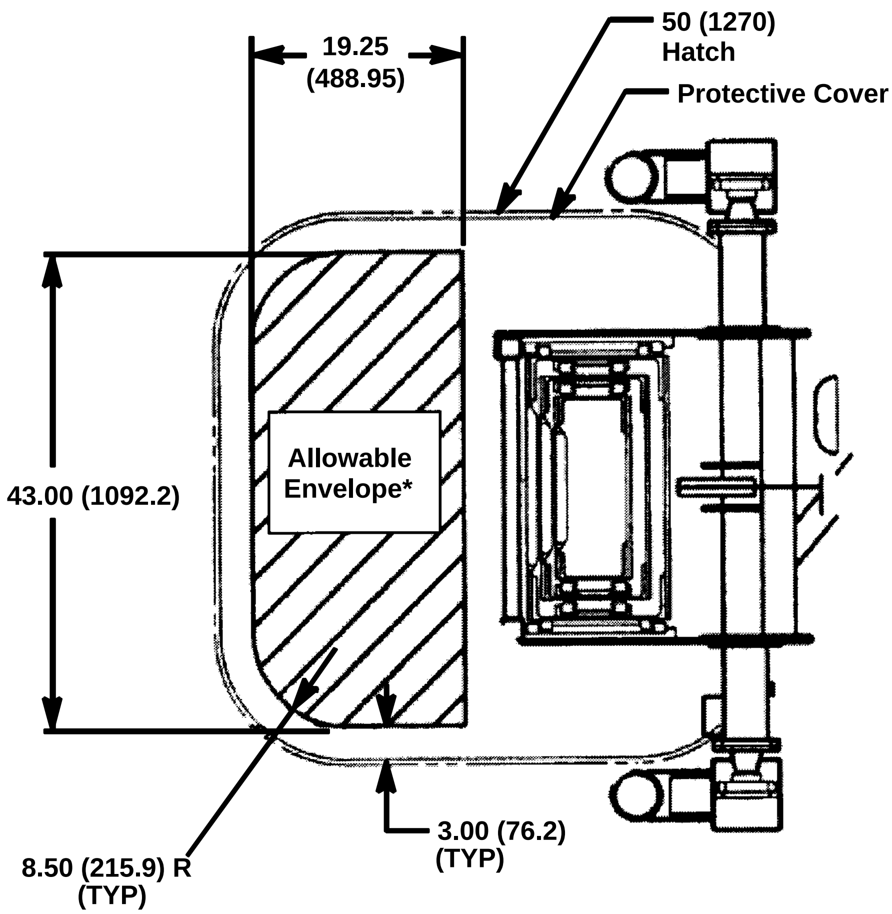
MPLM late/early access payloads, equipment items, samples and associated GSE weight shall not exceed 250 lbs per individual transfer.

3.1.1.2.1.1 MPLM LATE ACCESS ENVELOPE (KSC)

A. Payloads, equipment items, samples and associated GSE requiring MPLM late access shall comply with the hatch envelope defined in Figure 3.1.1.2.1.1–1.

B. Payloads, equipment items, samples and associated GSE requiring MPLM late access shall comply with the late access hoist hook interface defined in Figure 3.1.1.2.1.1–2.

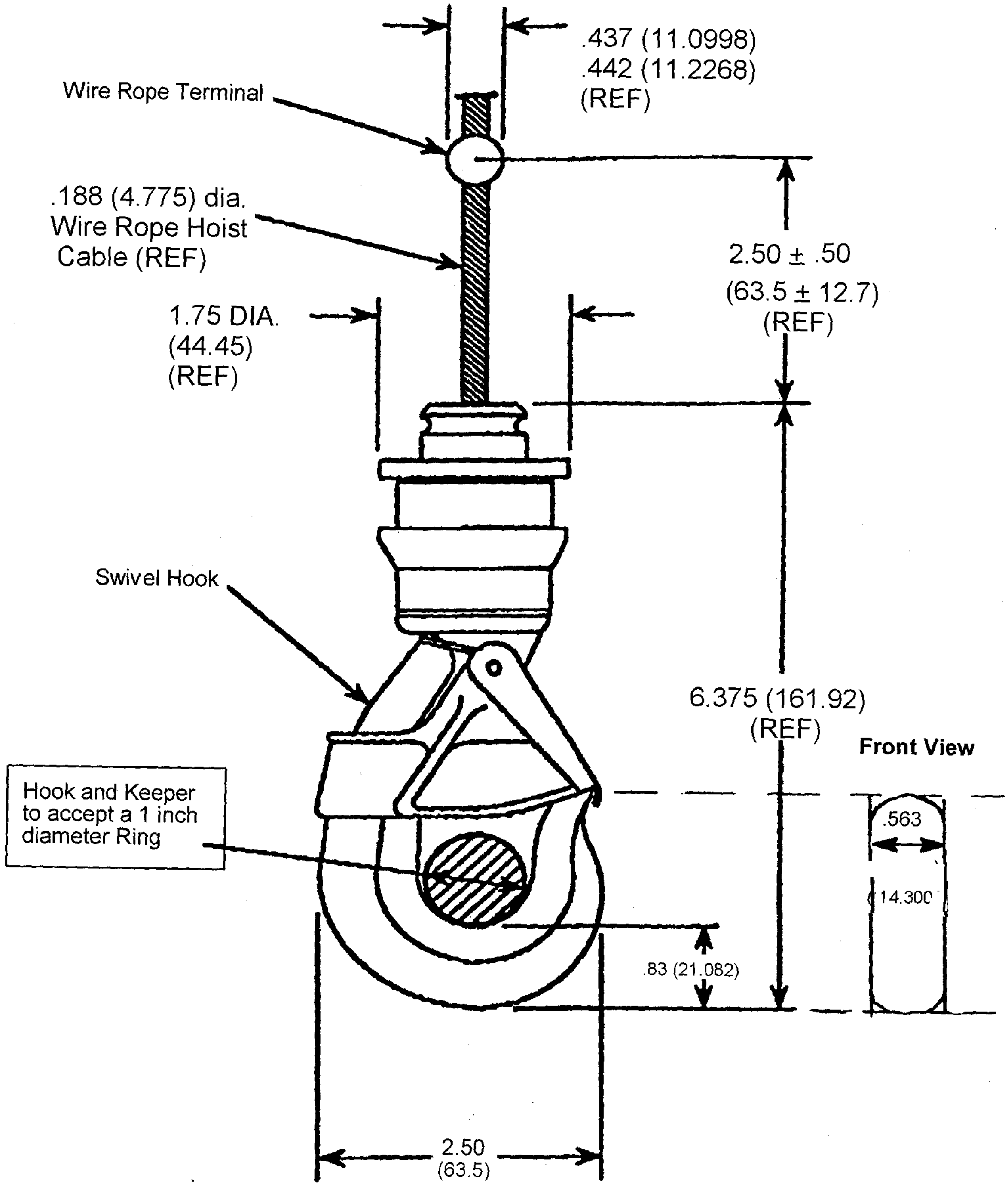
C. Payloads, equipment items, samples and associated GSE requiring MPLM late access shall comply with the late access monorail hook hoist interface defined in Figure 3.1.1.2.1.1–3.



*The allowable height of this envelope is 40 inches.

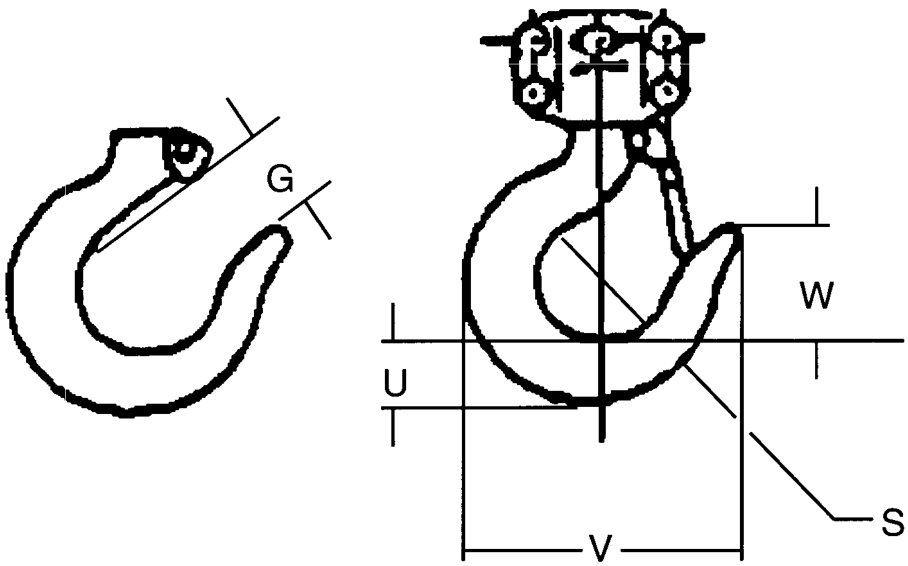
Inches (millimeters)

FIGURE 3.1.1.2.1.1–1 LATE ACCESS PAYLOAD ENVELOPE



Inches (millimeters)

FIGURE 3.1.1.2.1.1–2 LATE ACCESS HOIST HOOK



Dimensions (inches and mm)				
G	S	U	V	W
1.062 (26.975)	1.687 (42.85)	1.062 (26.975)	3 (76.2)	1.375 (34.925)

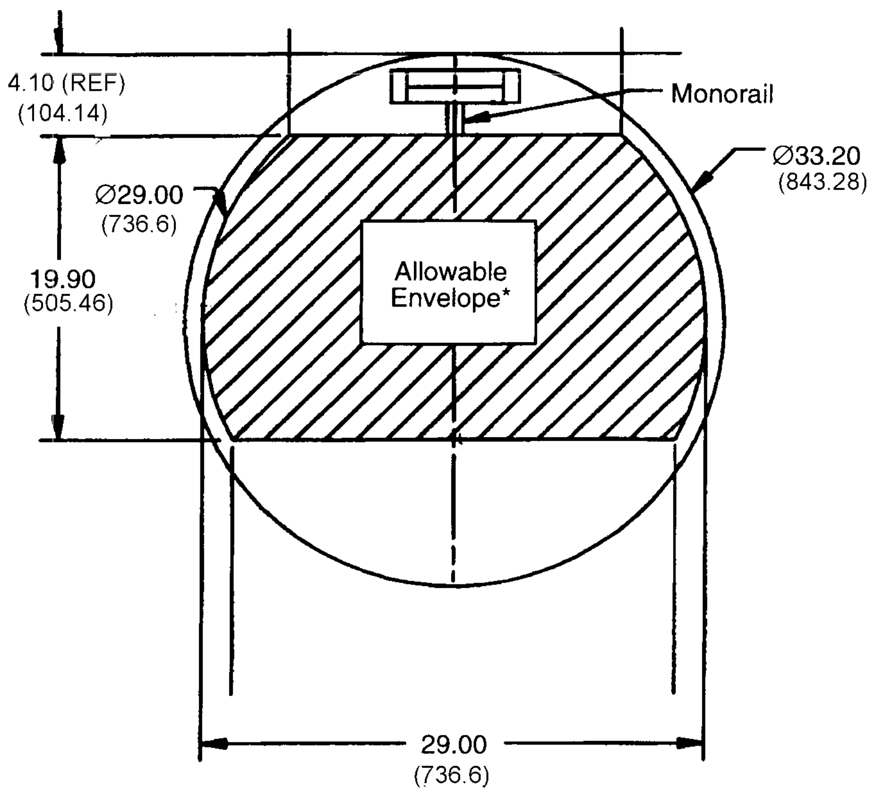
Note: Hook and kepper to accept a 1 inch diameter ring.

FIGURE 3.1.1.2.1.1–3 LATE ACCESS MONORAIL HOIST HOOK

3.1.1.2.1.2 MPLM EARLY ACCESS ENVELOPES (KSC AND DFRC)

A. Payloads, equipment items, samples and associated GSE requiring MPLM early access shall comply with the orbiter docking system (ODS) envelope defined in Figure 3.1.1.2.1.2–1.

B. Payloads, equipment items, samples and associated GSE requiring MPLM early access shall comply with the Dryden Early Access Platform (DEAP) monorail interface defined in Figure 3.1.1.2.1.2–2.



*The allowable length of this envelope is 43 inches.

Inches (millimeters)

FIGURE 3.1.1.2.1.2–1 EARLY ACCESS PAYLOAD ENVELOPE

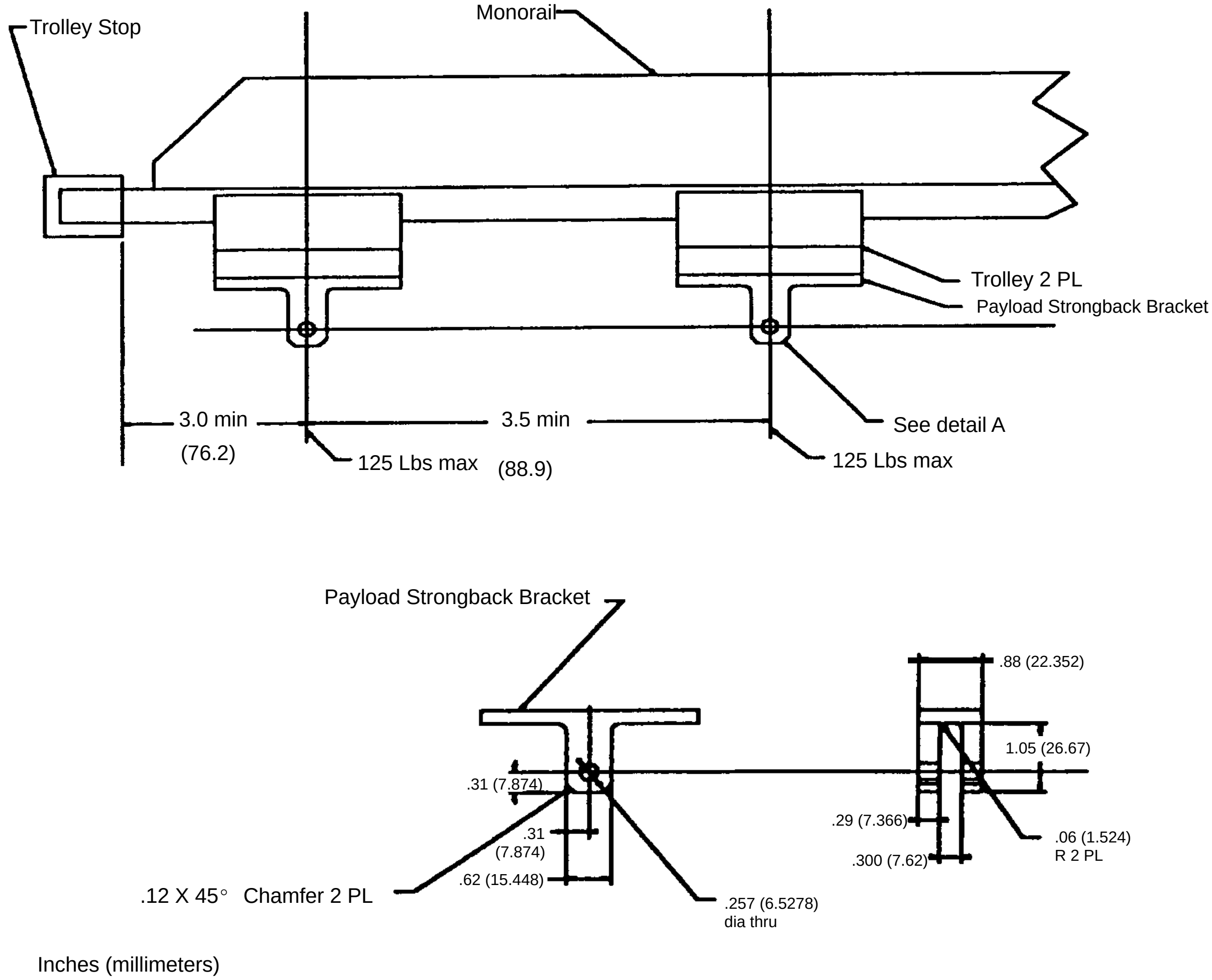


FIGURE 3.1.1.2.1.2–2 EARLY ACCESS DEAP MONORAIL INTERFACE

3.1.1.3 LOADS REQUIREMENTS

A. Integrated racks shall provide positive margins of safety for launch and landing loading conditions in the MPLM based upon an acceleration environment as defined in SSP 41017 Part 1, paragraph 3.2.1.4.2. Loads should be applied consistent with the rack coordinate system defined in SSP 41017, Part 2, paragraph 3.1.3.

B. Integrated racks shall provide positive margins of safety for on-orbit loads of 0.2 Gs acting in any direction.

C. Rack Utility Panel (RUP) umbilicals shall be restrained during launch and landing to prevent damage to loose connectors from loads and vibration.

D. Integrated rack equipment shall provide positive margins of safety when exposed to the crew induced loads defined in Table 3.1.1.3–1, Crew-Induced Loads.

E. For design and qualification purposes, components mounted to ISPR posts shall maintain positive margins of safety for the MPLM ascent random vibration environment as defined in Table 3.1.1.3–2, "Random Vibration Criteria for ISPR Post-Mounted Equipment Weighing 100 Pounds or Less in the MPLM", or Table 3.1.1.3–3, "Random Vibration Criteria for ISPR Post–Mounted Equipment Weighing More Than 100 Pounds in the MPLM."

TABLE 3.1.1.3–1 CREW-INDUCED LOADS

CREW SYSTEM OR STRUCTURE	TYPE OF LOAD	LOAD	DIRECTION OF LOAD
Levers, Handles, Operating Wheels, Controls	Push or Pull concentrated on most extreme edge	222.6 N (50 lbf), limit	Any direction
Small Knobs	Twist (torsion)	14.9 N–m (11 ft-lbf), limit	Either direction
Exposed Utility Lines (Gas, Fluid, and Vacuum)	Push or Pull	222.6 N (50 lbf)	Any direction
Rack front panels and any other normally exposed equipment	Load distributed over a 4 inch by 4 inch area	556.4 N (125 lbf), limit	Any direction
Legend: ft = feet, m = meter, N = Newton, lbf = pounds force			

TABLE 3.1.1.3–2 RANDOM VIBRATION CRITERIA FOR ISPR POST-MOUNTED EQUIPMENT WEIGHING 100 POUNDS OR LESS IN THE MPLM

FREQUENCY	LEVEL
20 Hz	0.005 g^2/Hz
20–70 Hz	+ 5.0 dB/oct
70–200 Hz	0.04 g^2/Hz
200–2000 Hz	–3.9 dB/oct
2000 Hz	0.002 g^2/Hz
Composite	4.4 grms
Note: Criteria is the same for all directions (X,Y,Z)	

TABLE 3.1.1.3–3 RANDOM VIBRATION CRITERIA FOR ISPR POST-MOUNTED EQUIPMENT WEIGHING MORE THAN 100 POUNDS IN THE MPLM

FREQUENCY	LEVEL
20 Hz	0.002 g^2/Hz
20–70 Hz	+ 4.8 dB/oct
70–150 Hz	0.015 g^2/Hz
150–2000 Hz	–3.7 dB/oct
2000 Hz	0.0006 g^2/Hz
Composite	2.4 grms
Note: Criteria is the same for all directions (X,Y,Z)	

F. Components mounted to the ISPRs shall maintain positive margins of safety for the launch and landing conditions in the MPLM. For early design, the acceleration environment defined in Table 3.1.1.3–4, “Payload Mounted Equipment Load Factors (Equipment Frequency 35 Hz)” will be used. These load factors will be superseded by load factors obtained through ISS-performed Coupled Loads Analysis as described in SSP 52005.

TABLE 3.1.1.3–4 PAYLOAD ISPR MOUNTED EQUIPMENT LOAD FACTORS (EQUIPMENT FREQUENCY 35 HZ)

Liftoff	**X**	**Y**	**Z**
(g)	± 7.7	± 11.6	± 9.9
Landing	**X**	**Y**	**Z**
(g)	± 5.4	± 7.7	± 8.8
Note: Load factors apply concurrently in all possible combinations for each event and are shown in the rack coordinate system defined in SSP 41017, Part 2, paragraph 3.1.3.			

3.1.1.4 RACK REQUIREMENTS

A. Integrated racks shall be limited to 804.2 kg (1773 lbs) for launch and landing in the MPLM and for ground and on-orbit operations.

B. Integrated racks shall maintain positive margins of safety for the on–orbit depress/repress rates identified in SSP 41002 paragraph 3.1.7.2.1.

C. The integrated rack and kneebrace shall have a modal frequency in accordance with SSP 52005 paragraph 5.7, second paragraph for launch and landing, based on rigidly mounting the integrated rack in the launch configuration.

D. Equipment mounted directly to the rack will have a modal frequency goal of 35 Hz for launch and landing, based on rigidly mounting the component at the component to rack interface.

E. Integrated racks shall comply with the keepout zone for rack pivot mechanism as defined in SSP 41017 Part 1, paragraph 3.2.1.1.2.

F. Integrated racks that will be installed in the U.S. Lab Nadir Window location shall accommodate the modified ISPR static envelope defined by Figure 3.1.1.4–1 of the Pressurized Payload Hardware ICD, SSP 57001.

G. Deleted

H. Deleted

I. Integrated racks shall be capable of rotating a minimum of 80 degrees about the pivot point for on-orbit installation, removal, and maintenance functions.

J. Deleted

K. Integrated racks and rack equipment that have PFE access ports shall maintain positive margins of safety when exposed to the PFE discharge rate given in Figure 3.1.1.4–1.

L. Integrated racks requiring rotation shall use the rack and crew restraints identified in SSP 30257:004 (for example, the 14 inch fixed length tether and the 71 inch adjustable length tether) to secure the rack in these rotated positions for payload operations and maintenance.

M. Integrated racks shall not have a pressure relief device on the front of the rack except for pressure relief devices that are only used to minimize the pressure differential across an enclosed volume due to changes in the normal cabin operating pressure as defined in Figure 3.9.4–1.

N. Integrated racks shall comply with the on–orbit keep–out zone for KBAR as defined in SSP 41017 Part 1, Figure 3.2.1.1.2–1 Rack Static Envelope (Side View) and 3.2.1.1.2–2 Rack Static Envelope (Front View).

O. Integrated Payload Racks that utilize ARIS, in on–orbit laboratory modules, shall accommodate the snubber keep–out envelope defined in SSP 57005, section 3.2.1.3.1.

P. Integrated racks that are designed to rotate shall be free to rotate fully as specified in 3.1.1.4.I while connected to rack utilities (e.g. power, data, video, and fluid lines) from the pressurized element. Note: This requirement does not apply to the following racks: Racks utilizing ARIS or PaRIS, MELFI, WORF, EXPRESS, HRF Rack 1, HRF Rack 2, CR (Centrifuge Rotor) and LSG.

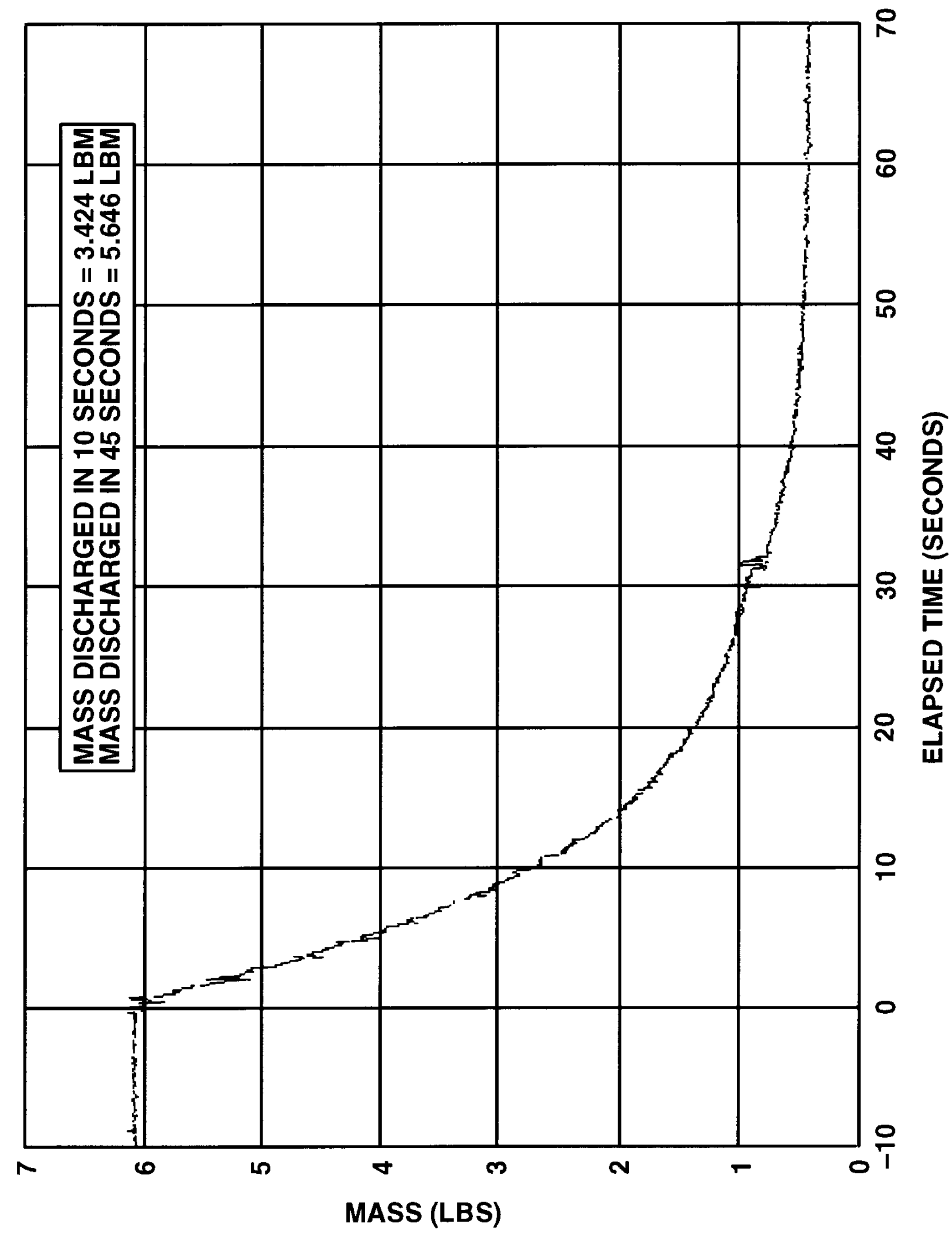


FIGURE 3.1.1.4–1 MANUAL FIRE SUPPRESSION SYSTEM PERFORMANCE CHARACTERISTICS AT THE RACK I/F

Q. Integrated racks that have a pressure relief device on the front of the rack to minimize the pressure differential across an enclosed volume due to changes in the nominal cabin operating pressure shall not be activated when exposed to the PFE discharge rate given in Figure 3.1.1.4–1.

R. Integrated racks shall have seat track installed in the locations defined in SSP 41017, Part 2, Figure 3.3.5–1.

S. Integrated racks that will be installed in the JEM, except for MELFI, shall provide seat tracks or provide the capability to install a Seat Track Adapter Assembly (STAA), part number 683–60110, on–orbit in the locations defined in Figure 3.1.1.4–2. This is to aid the crew in module maintenance by using a Foot Restraint attached on the rear side of a rotated rack within the ISS.

3.1.1.4.1 LAB WINDOW RACK LOCATION REQUIREMENTS

When the lab window scratch pane is removed, radiation shielding as specified in 3.9.3.4 is required.

A. When the lab window scratch pane is removed, a protective cover shall be provided that prevents contact with the lab window surface.

B. Integrated racks at the lab window location shall accommodate a keep–out zone as specified in SSP 57001, Figure 3.1.1.4–1.

C. Integrated racks at the lab window location, that are open on the back (window) side of the rack, shall provide a barrier from the Lab pressure wall to the integrated rack to isolate the rack volume from the stand–offs and area behind the racks.

D. Payloads that are hand–held, regardless of whether the WORF rack is installed or not, shall incorporate bumper rings coated with the material DB2352 from the Plasti–Coat Corporation to prevent damage to any window panes in the USL nadir window. Payloads that are designed to be secured to the WORF payload shelf prior to retraction of the Bump Shield will be exempted from this requirement.

3.1.1.5 SAFETY CRITICAL STRUCTURES REQUIREMENTS

Integrated racks shall be designed in accordance with the requirements specified in SSP 52005.

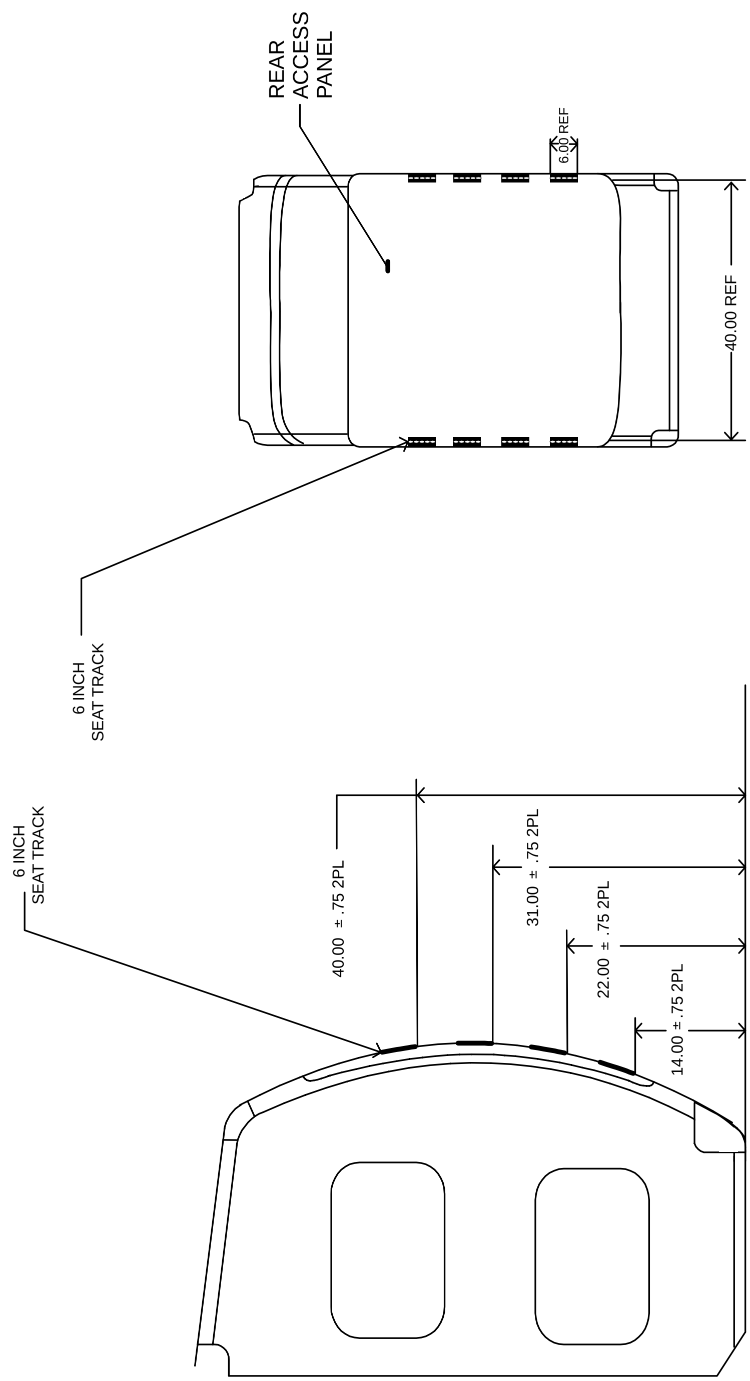


FIGURE 3.1.1.4–2 ATTACHMENT AIDS FOR RACK ASSEMBLY BACK FACE

3.1.1.6 CONNECTOR AND UMBILICAL PHYSICAL MATE

3.1.1.6.1 CONNECTOR PHYSICAL MATE

Integrated rack and sub-rack equipment shall physically mate with the UIP, UOP and Fluid Services connectors intended to be used by the payload as listed in Table 3.1.1.6.1–1.

TABLE 3.1.1.6.1–1 MODULE CONNECTORS

	Module Connector	Module Part Number	Resource
UIP			
A	J1	NATC07T25LN3SN	Main Power
B	J2	NATC07T25LN3SA	Essential/Auxiliary Power
C	J3	NATC07T15N35SN	1553 Bus A
D	J4	NATC07T15N35SA	1553 Bus B
E	J7	NATC07T13N4SN	HRDL
F	J16	NATC07T15N97SB	Optical Video
G	J43	NATC07T13N35SA	FDS/Power Maintenance
H	J45	NATC07T11N35SC	EWACS
I	J46	NATC07T11N35SA	LAN–1
J	J47	NATC07T11N35SB	LAN–2
K	J77	NATC07T13N35SB	Electrical Video
L	TCS Mod Supply	683–16348, male, Category 6, Keying B	TCS Mod Supply
M	TCS Mod Return	683–16348, male, Category 6, Keying C	TCS Mod Return
N	TCS Low Supply	683–16348, male, Category 6, Keying B	TCS Low Supply
O	TCS Low Return	683–16348, male, Category 6, Keying C	TCS Low Return
P	GN2	683–16348, male, Category 8, Keying B	GN2
Q	Vacuum Exhaust	683–16348, male, Category 3, Keying B	Vacuum Exhaust
R	Vacuum Resource	683–16348, male, Category 3, Keying A	Vacuum Resource
S	Ar	683–16348, male, Category 8, Keying C	AR
T	He	683–16348, male, Category 8, Keying E	HE
U	CO2	683–16348, male, Category 8, Keying D	CO2
FLUID SERVICES			
V	Potable Water	683–16348, male, Category 7, Keying D	Potable Water
W	Fluid System Servicer	683–16348, male, Category 6, Universal (no–keying)	Fluid System Servicer
UOP			
X	J3	NATC00T15N97SN	Power/1553 Bus
Y	J4	NATC00T15N97SN	Power/1553 Bus
Z	J4	NATC00T15N97SA	Power/Ethernet
Notes:	1. Integrated rack connector part numbers are listed in the appropriate sections of SSP 57001. 2. UOP connector architecture is specified in SSP 57001, paragraph 3.2.1.2.		
SUP			
AA	J1	NATC00T15N97SN	Power/Data
AB	J2	NATC00T15N97SN	Power/Data
AC	J3	NATC00T15N97SN	Power
AD	J4 (SUP – 1 & 4 only)	NATC00T15N35SN	APM Payload 1553 Bus
AE	J5	NATC00T11N35SN	APM IEEE 802.3 Nominal LAN
AF	J6 (SUP – 1 & 4 only)	NATC00T15N97SN	Video/High Rate Data
AG	J7 (SUP – 1 & 4 only)	NATC00T13N35SA	Smoke Sensor/EWACS
AH	J8	Reserved	Reserved
AI	J9	NATC00T11N35SN	APM IEEE 802.3 Redundant LAN

3.1.1.6.2 UMBILICAL PHYSICAL MATE

Integrated racks shall provide a Rack Utility Panel and umbilicals that allow connection of rack utilities from the rack to the standoff Utility Interface Panel defined in SSP 41002, Figure 3.2.2-1 and the appropriate Utility Interface Panel connector layout defined in SSP 41002, Figures 3.3-1 through 3.3-5.

3.1.1.7 ON–ORBIT PAYLOAD PROTRUSIONS

Definitions for on–orbit permanent protrusions, on–orbit semi–permanent protrusions, on–orbit temporary protrusions, on–orbit momentary protrusions, and protrusions for on–orbit keep alive payloads can be found in Appendix B, Glossary of Terms. The requirements in section 3.1.1.7 apply to installation and operation activities, but not to maintenance activities.

Note: The on–orbit protrusion requirements in this section are applicable to when the payload is on–orbit and do not apply to other phases of the transportation of the payload (e.g., launch, landing, MPLM installation).

A. On–orbit protrusions, excluding momentary protrusions, shall not extend laterally across the edges of the rack or pass between racks.

B. The integrated rack hardware, excluding momentary protrusions, shall not prevent attachment of RMA on any seat track attach holes.

Constraints which may be associated with payload protrusions include:

- removal of the protrusion during rack installation, translation, and crew translation
- removal of the protrusion if RMA is installed on the rack
- removal of the protrusion to prevent interference with microgravity operations
- removal or powering off of the rack if the protrusion blocks PFE access or the fire indicator
- may limit the rack location (e.g., Protrusion located in the floor and the ceiling are limited to a total of no more than 12 inches.)
- may limit operation of the payload

As is indicated by the constraints above, protrusions have a negative impact on crew operations and are to be minimized.

3.1.1.7.1 ON–ORBIT PERMANENT PROTRUSIONS

The integrated rack shall not allow permanent protrusions.

3.1.1.7.2 ON–ORBIT SEMI–PERMANENT PROTRUSIONS

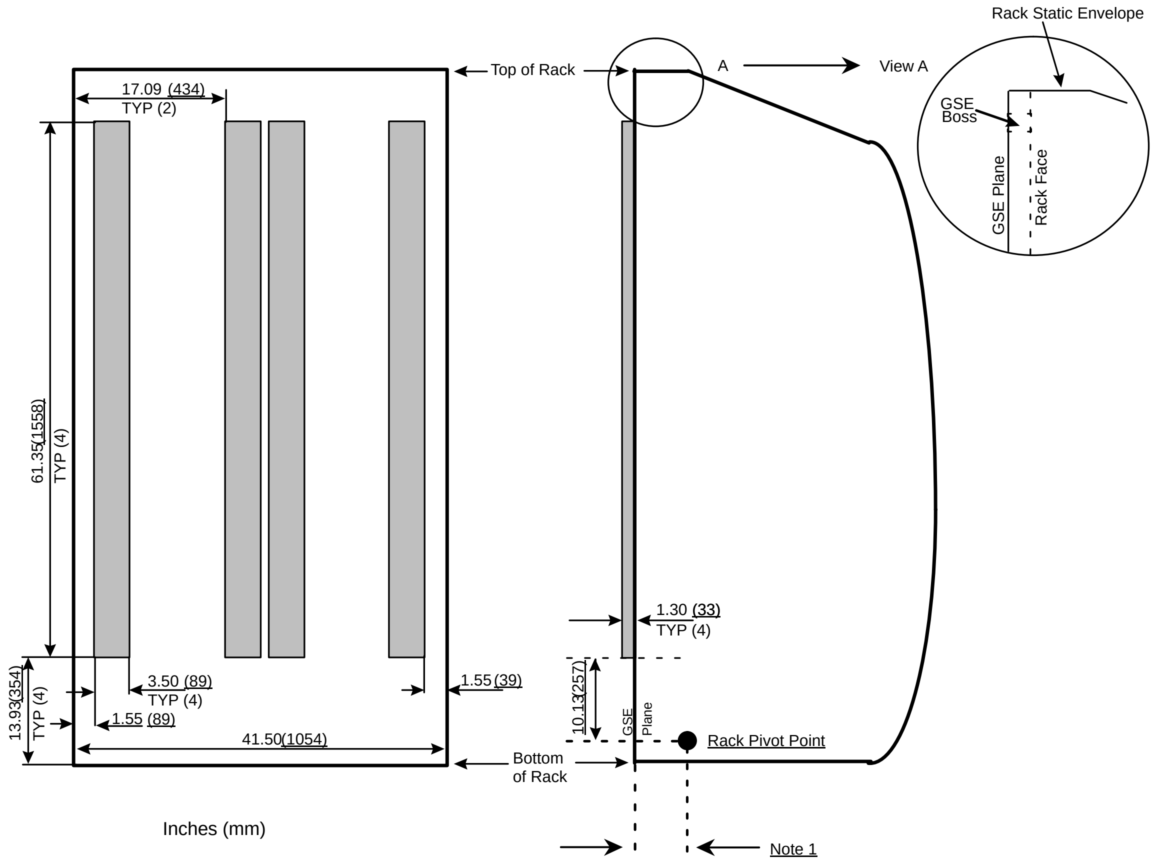
A. SIR and ISIS drawer handles shall remain within the envelope shown in Figure 3.1.1.7.2–1.

B. Other on–orbit semi–permanent protrusions shall be limited to no more than 500 square inches within the envelope shown in Figure 3.1.1.7.2–2.

Note: The sum of the on–orbit semi–permanent protrusions and the on–orbit protrusion for keep alive payloads is limited to no more than 500 square inches.

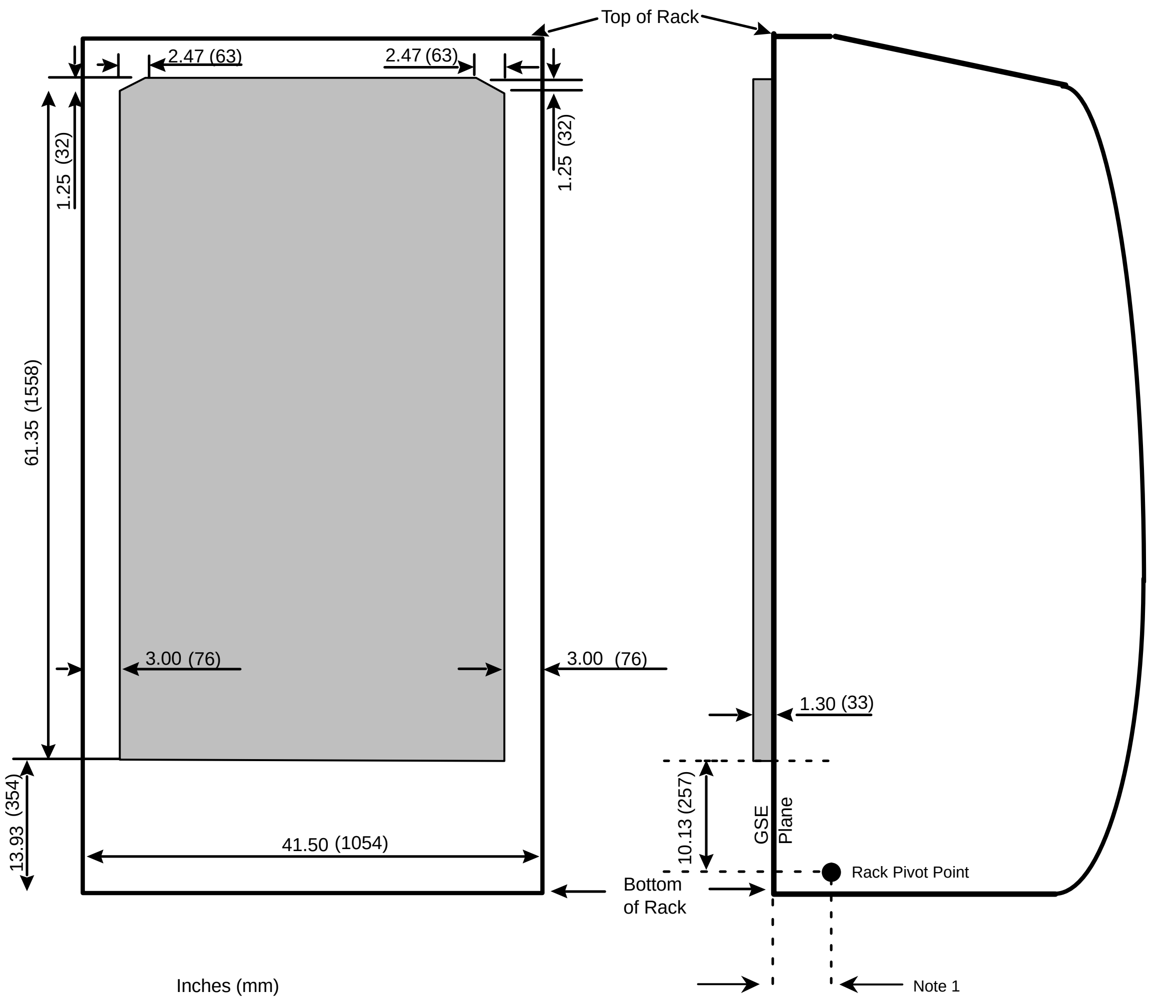
Note: The SIR and ISIS drawer handles are not included in the 500 square inch limit.

C. All on–orbit semi–permanent protrusions shall be designed to be removable by the crew with hand operations and/or standard IVA tools.



Note:
1. The dimension for a Boeing ISPR is 3.50 (89). The dimension for a NASDA ISPR is 2.47 (63).

FIGURE 3.1.1.7.2–1 SIR AND ISIS DRAWER HANDLES PROTRUSION ENVELOPE



Note:
1. The dimension for a Boeing ISPR is 3.50 (89). The dimension for a NASDA ISPR is 2.47 (63).
2. Protrusions are limited to 1.3 (33mm) inches for ground processing and launch/landing as described in paragraph 3.1.1.1.A

FIGURE 3.1.1.7.2–2 ON–ORBIT SEMI–PERMANENT PROTRUSIONS ENVELOPE

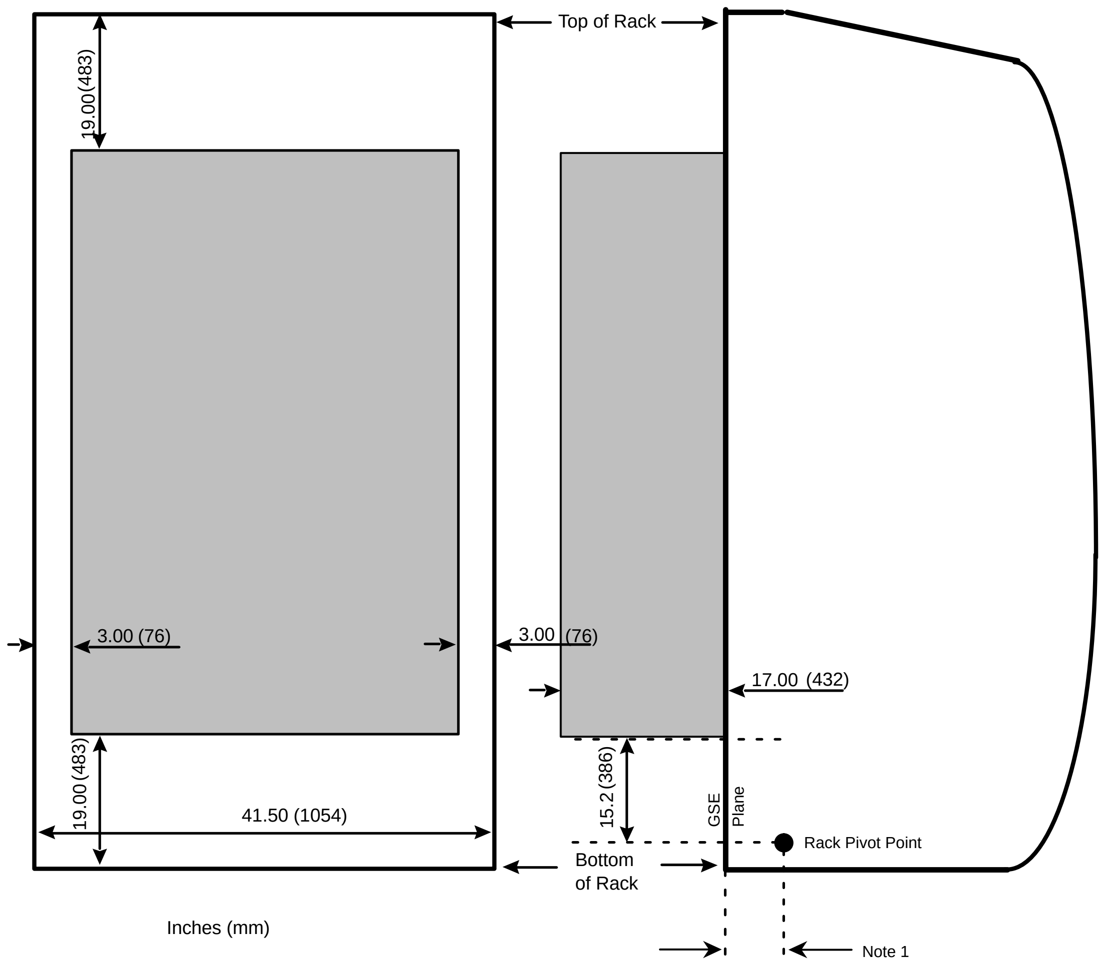
3.1.1.7.3 ON–ORBIT TEMPORARY PROTRUSIONS

A. On–orbit temporary protrusions shall remain within the envelope shown in Figure 3.1.1.7.3–1.

B. The combination of all on–orbit temporary protrusions for the integrated rack shall be designed such that they can be eliminated or returned to their stowed configuration by the crew with hand operations and/or standard IVA tools within 10 minutes.

Note: Integrated racks must provide stowage for on–orbit temporary protrusions within their stowage allocation.

Note: On–orbit temporary protrusions for payloads located in the floor or ceiling are limited to 6 inches each or a total of 12 inches for both floor and ceiling.



Note:
1. The dimension for a Boeing ISPR is 3.50 (89). The dimension for a NASDA ISPR is 2.47 (63).
2. Protrusions are limited to 1.3 (33mm) inches for ground processing and launch/landing as described in paragraph 3.1.1.1.A
3. The A1 and F1 positions in the JEM can not accommodate temporary protrusions due to the interference with the Intermodule Ventilation (IMV) function.

FIGURE 3.1.1.7.3–1 ON–ORBIT TEMPORARY PROTRUSIONS ENVELOPE

3.1.1.7.4 ON–ORBIT MOMENTARY PROTRUSIONS

On–orbit momentary protrusions shall be designed such that they can be eliminated within 30 seconds.

3.1.1.7.5 ON–ORBIT PROTRUSIONS FOR KEEP ALIVE PAYLOADS

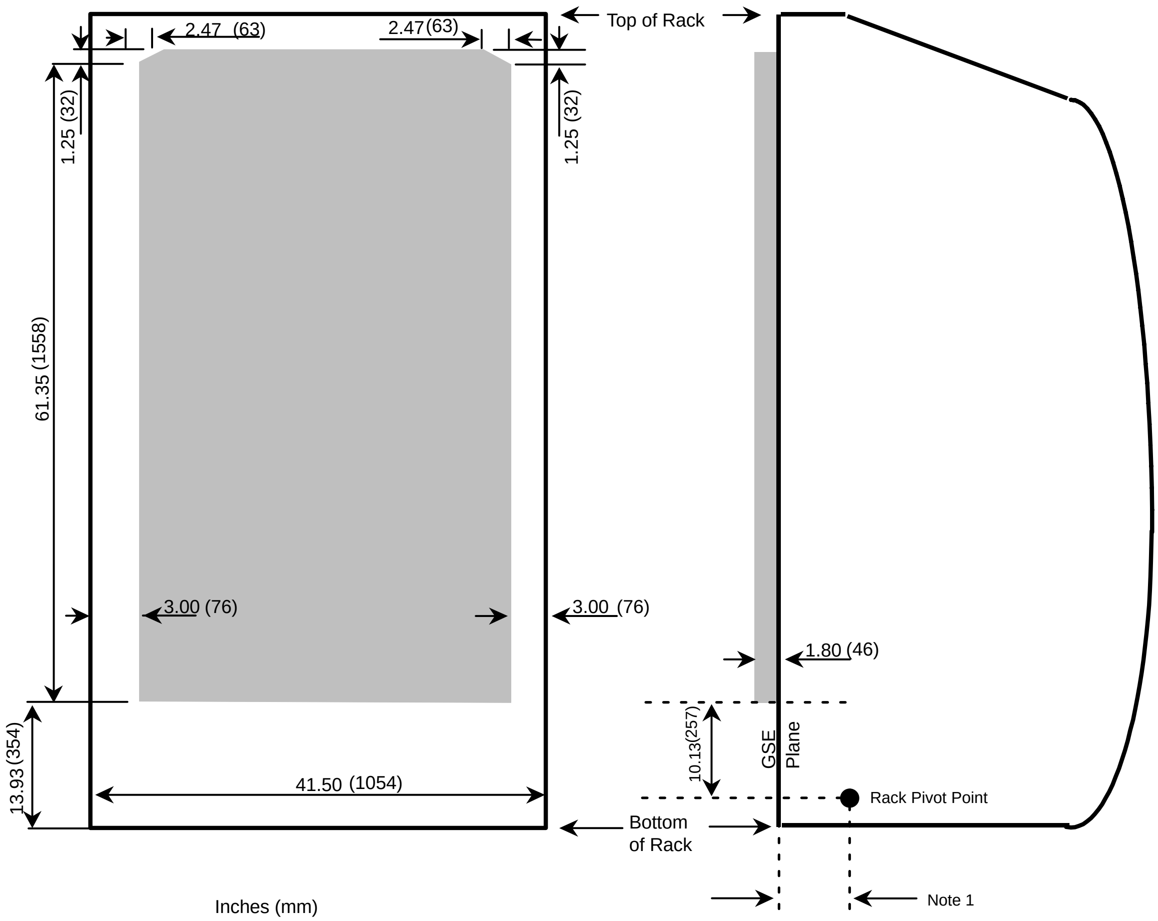
A. On–orbit protrusions for keep alive payloads experiments, (these are only power/data cables and thermal hoses) shall be limited to no more than 500 square inches within the envelope shown in Figure 3.1.1.7.5–1.

Note: The sum of the on–orbit semi–permanent protrusions and the on–orbit protrusion for keep alive payloads is limited to no more than 500 square inches.

B. The following two requirements are applicable only to the Habitat Holding Racks, Advanced Animal Habitat, Aquatic Habitat, Cell Culture Unit, Egg Incubator, Insect Habitat, Plant Research Unit, Incubator, Refrigerated Centrifuge.

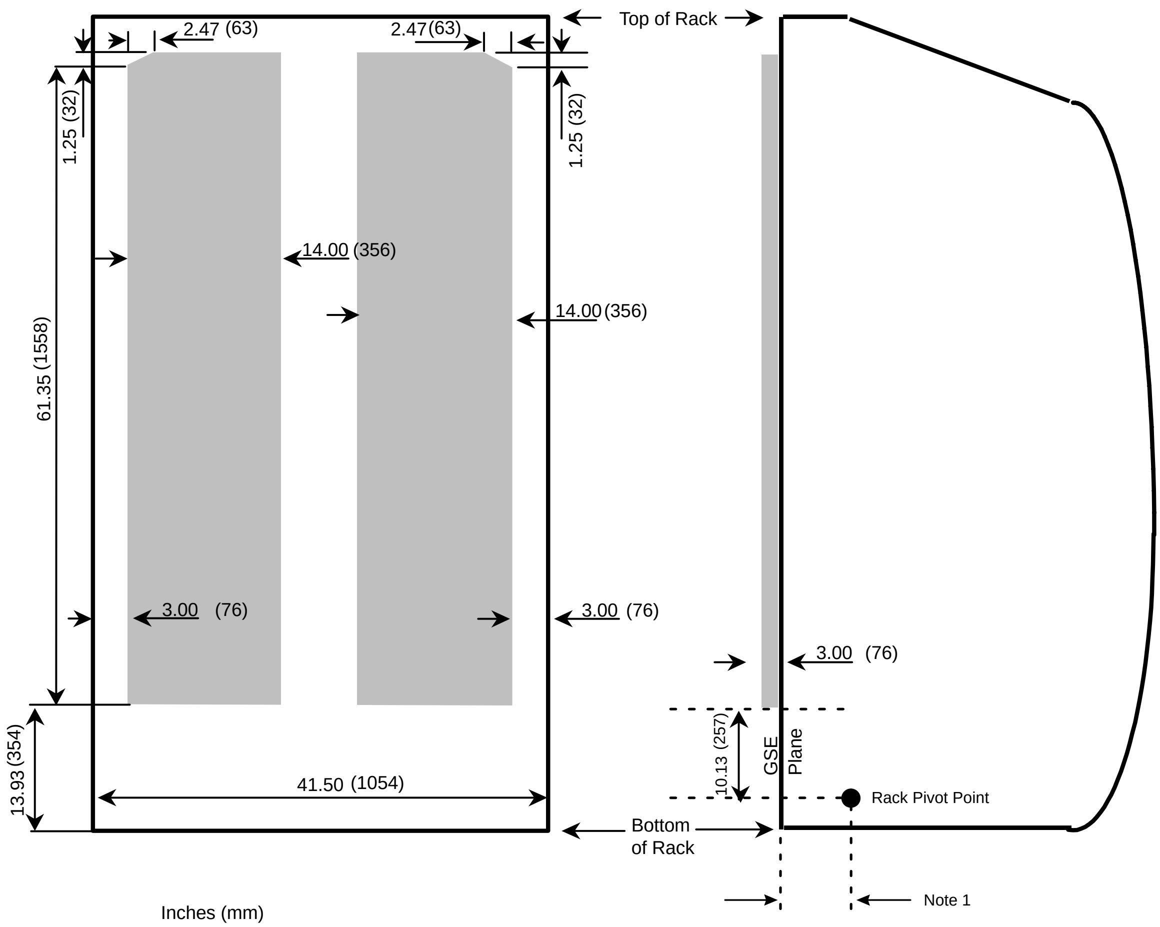
(1) The mated low temperature fluid line connector and associated connection hardware shall be limited to 100 square inches within the envelope shown in Figure 3.1.1.7.5–2. The ISIS drawer fluid lines are to be pulled under the 2–inch protrusion envelope shown in Figure 3.1.1.7.5–3 as soon as the bend radius allows.

(2) The air filters and low temperature fluid lines shall be limited to 900 square inches within the envelope shown in Figure 3.1.1.7.5–3.



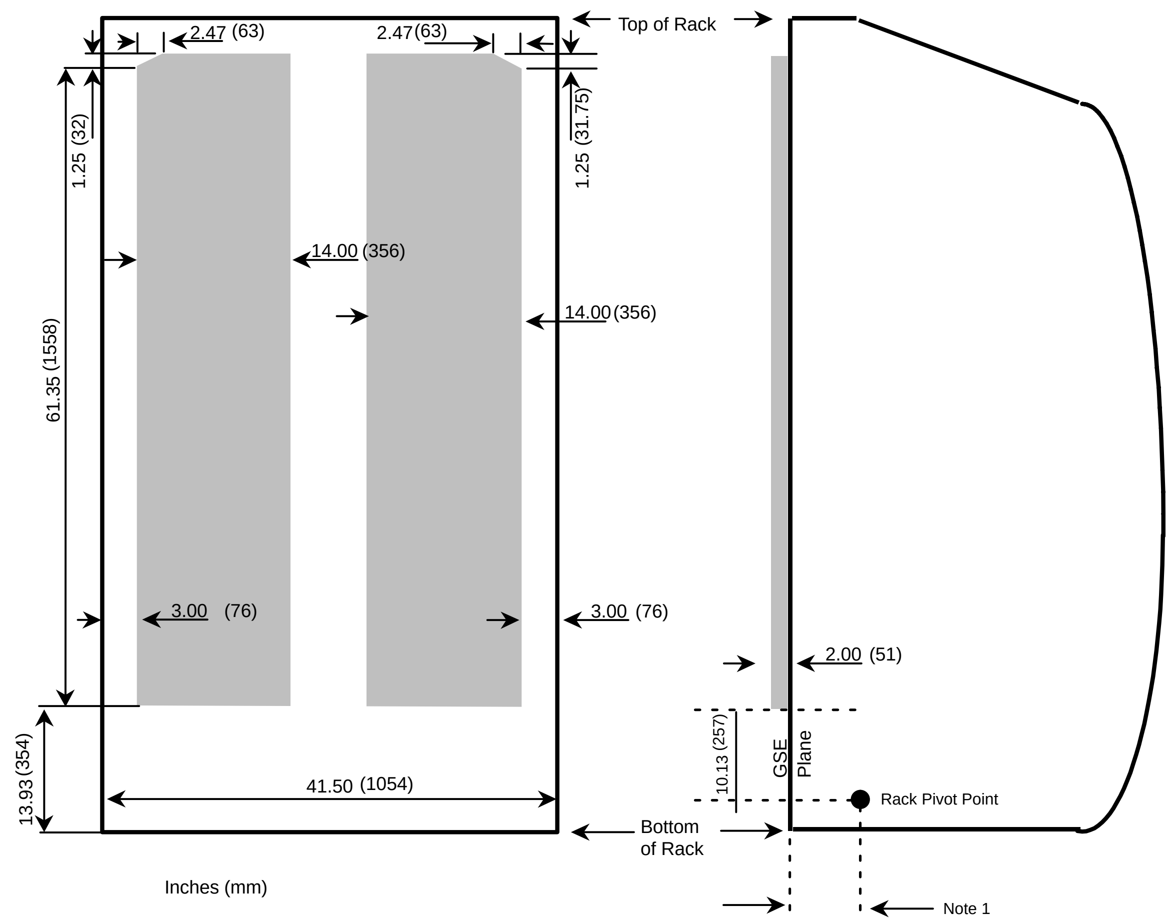
Note:
1. The dimension for a Boeing ISPR is 3.50 (89). The dimension for a NASDA ISPR is 2.47 (63).
2. Protrusions are limited to 1.3 (33mm) inches for ground processing and launch/landing as described in paragraph 3.1.1.1.A.

FIGURE 3.1.1.7.5–1 ON–ORBIT PROTRUSIONS FOR KEEP ALIVE PAYLOADS ENVELOPE



Note:
1. The dimension for a Boeing ISPR is 3.50 (89). The dimension for a NASDA ISPR is 2.47 (63).

FIGURE 3.1.1.7.5–2 ISIS FLUID LINE ENVELOPE FOR 3–INCH PROTRUSIONS



Note:
1. The dimension for a Boeing ISPR is 3.50 (89). The dimension for a NASDA ISPR is 2.47 (63).

FIGURE 3.1.1.7.5–3 ISIS FLUID LINE ENVELOPE FOR 2–INCH PROTRUSIONS

3.1.2 MICROGRAVITY

Microgravity requirements are defined to limit the disturbing effects of Integrated Racks and non–rack payloads on the microgravity environment of other payloads during microgravity mode periods. Non–rack payloads will be given a one quarter rack microgravity disturbance allocation. These requirements are separated into the quasi–steady category for frequencies below 0.01 Hz, the vibratory category for frequencies between 0.01 Hz and 300 Hz, and the transient category. For integrated racks, the interface points are the locations on the ISS structure where rack attachment brackets or isolation systems connect to the ISS. These requirements will apply to all NASA developed payloads and to any IP developed payloads that will be located in the USL.

3.1.2.1 QUASI-STEADY REQUIREMENTS

For frequencies below 0.01 Hz, Integrated racks and non–rack payloads shall limit unbalanced transitional average impulse to generate less than 10 lb–s (44.8 N–s) within any 10 to 500 second period, along any ISS coordinate system vector.

3.1.2.2 VIBRATORY REQUIREMENTS

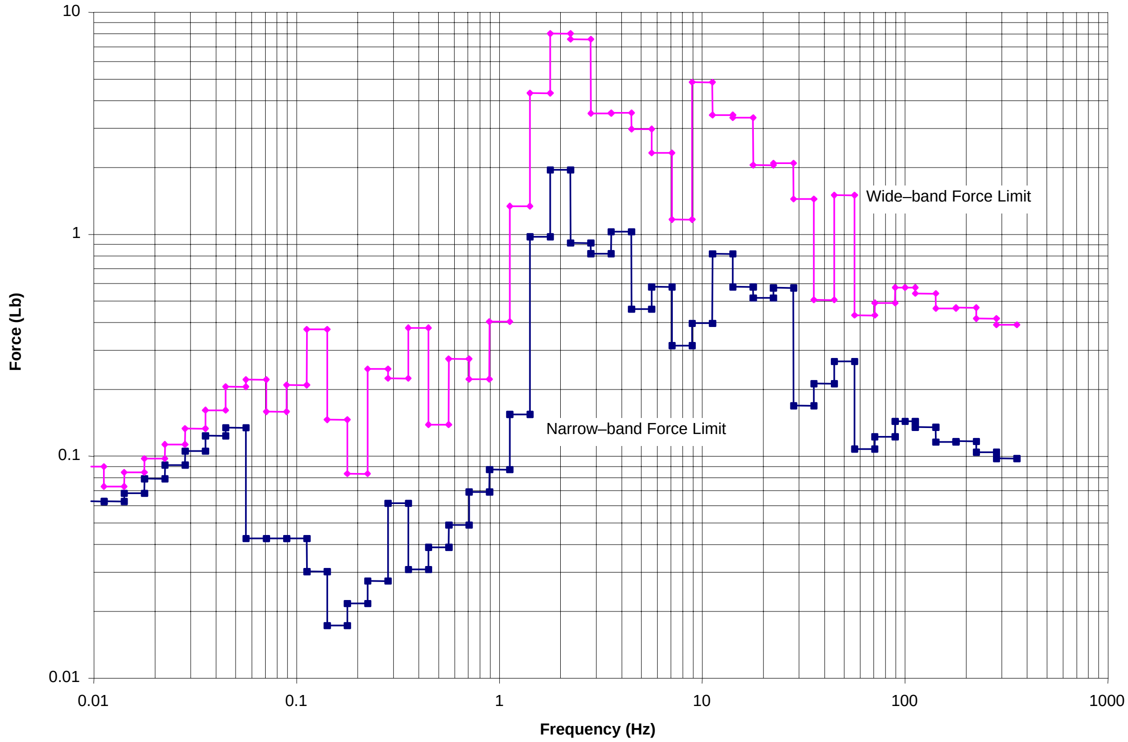
Between 0.01 and 300 Hz, Integrated Rack payloads without ARIS and inactive ARIS racks shall limit vibration so that the limits of Figure 3.1.2.2–1 are not exceeded using the force method, or the limits of Table 3.1.2.2–2 are not exceeded using the acceleration method. Non–Rack payloads shall limit vibration so that one–fourth of the limits of Figure 3.1.2.2–1 are not exceeded using the force method, or one–fourth the limits of Table 3.1.2.2–2 are not exceeded using the acceleration method.

PAYLOAD INTERFACE FORCE METHOD
The total force will be calculated as the RMS average of the forces at all interface points for inactive (latched) ARIS payload configurations, or the RSS of the forces at all interface points for non–ARIS payloads and Non–Rack payloads. The force at each interface point will be calculated to be the root–summed squared (RSS) in all axis, within each third octave band, during the worst case 100 second interval.

The forces within each 1/3 octave band will be classified as either wide–band or narrow–band. Forces will be classified as wide–band if the peak–to–average ratio is less than or equal to five, otherwise they will be classified as narrow–band. The peak to average ratio will be determined by dividing the peak power spectrum magnitude of the one–third octave band by the average magnitude within the band for the axis in which the peak occurs. The forces so classified will then be compared to the appropriate limit (wide or narrow band) in Figure 3.1.2.2–1.

OR

ADJACENT ARIS PAYLOAD ACCELERATION METHOD
The modeled payload induced acceleration at an immediately adjacent ARIS rack interface described by an ISS Program Office supplied model is to be used. The interfaces are to consist of the isolation plate, “Z” panel, and “light rails”, at which the RMS accelerations within any one–third octave band, over any 100 second period, are not to exceed the limits shown in Figure 3.1.2.2–2. Application of this technique requires that the payload developer use the ISS Program Office provided interface model in conjunction with payload FEM and/or SEA models to calculate the ARIS interface accelerations resulting from the worst case combination of payload disturbance sources.



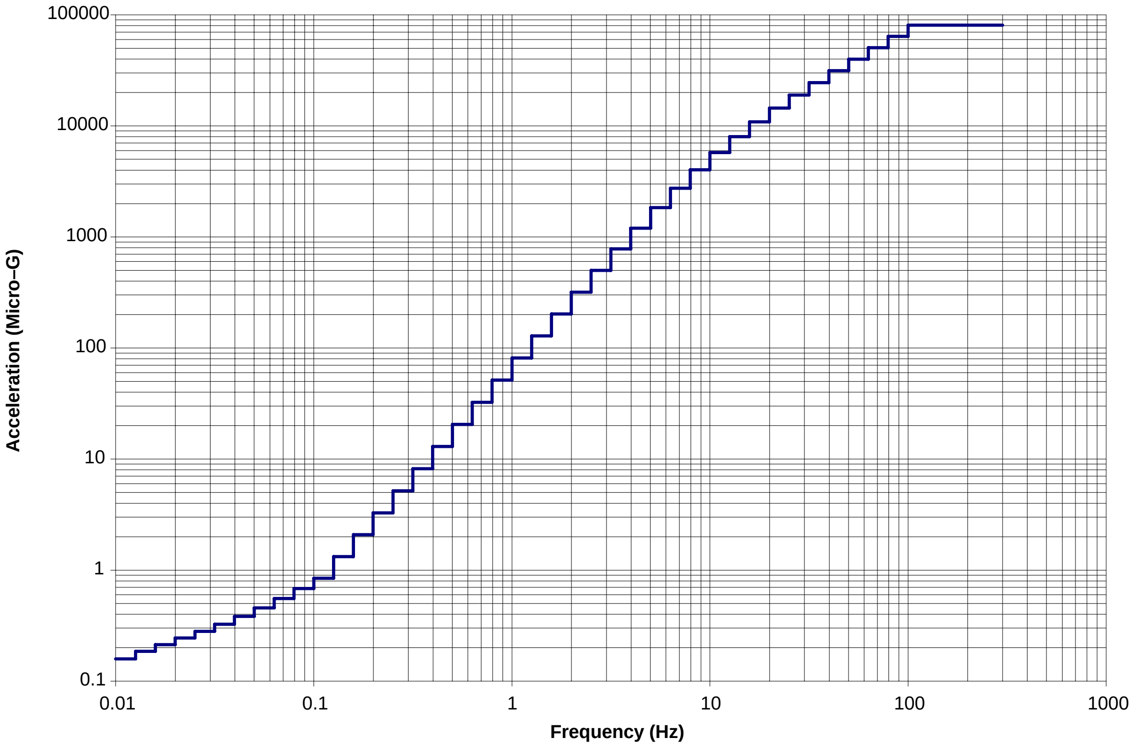
Note: Non–Rack Payloads are limited to one–fourth of this allocation.

FIGURE 3.1.2.2–1 ALLOWABLE ONE–THIRD OCTAVE INTERFACE FORCES FOR INTEGRATED RACKS AND NON–RACK PAYLOADS, 0.5% DAMPING FACTOR

TABLE 3.1.2.2–1 ALLOWABLE INTEGRATED RACK NARROW–BAND ENVELOPE AND WIDEBAND INTERFACE FORCE VALUES FOR ISPRS, 0.5% DAMPING FACTOR

Freq (Hz)	NB lb f	WB Lb f	Freq (Hz)	NB lb f	WB Lb f	Freq (Hz)	NB lb f	WB Lb f
0.008913	0.06261	0.089635	0.3548	0.061482	0.224779	11.22	0.817148	3.451307
0.01122	0.06261	0.089635	0.3548	0.030924	0.378806	14.13	0.817148	3.451307
0.01122	0.06261	0.073218	0.4467	0.030924	0.378806	14.13	0.579786	3.358266
0.01413	0.06261	0.073218	0.4467	0.038934	0.138909	17.78	0.579786	3.358266
0.01413	0.068172	0.084667	0.5623	0.038934	0.138909	17.78	0.516921	2.048448
0.01778	0.068172	0.084667	0.5623	0.04901	0.274588	22.39	0.516921	2.048448
0.01778	0.079202	0.097495	0.7079	0.04901	0.274588	22.39	0.57451	2.091627
0.02239	0.079202	0.097495	0.7079	0.06922	0.222568	28.18	0.57451	2.091627
0.02239	0.091377	0.112968	0.8913	0.06922	0.222568	28.18	0.168996	1.443748
0.02818	0.091377	0.112968	0.8913	0.087153	0.404688	35.48	0.168996	1.443748
0.02818	0.105641	0.133067	1.122	0.087153	0.404688	35.48	0.212776	0.50643
0.03548	0.105641	0.133067	1.122	0.154561	1.337042	44.67	0.212776	0.50643
0.03548	0.123739	0.161094	1.413	0.154561	1.337042	44.67	0.267886	1.498072
0.04467	0.123739	0.161094	1.413	0.976353	4.322593	56.23	0.267886	1.498072
0.04467	0.134457	0.205508	1.778	0.976353	4.322593	56.231	0.10793	0.431721
0.05623	0.134457	0.205508	1.778	1.953413	8.01995	70.79	0.10793	0.431721
0.05623	0.042699	0.22137	2.239	1.953413	8.01995	70.791	0.122491	0.489965
0.07079	0.042699	0.22137	2.239	0.915835	7.567684	89.13	0.122491	0.489965
0.07079	0.042699	0.158917	2.818	0.915835	7.567684	89.131	0.143827	0.575309
0.08913	0.042699	0.158917	2.818	0.818034	3.504552	100	0.143827	0.575309
0.08913	0.042699	0.2093	3.548	0.818034	3.504552	112.2	0.143827	0.575309
0.1122	0.042699	0.2093	3.548	1.029953	3.531682	112.2	0.135367	0.541469
0.1122	0.030213	0.373089	4.467	1.029953	3.531682	141.3	0.135367	0.541469
0.1413	0.030213	0.373089	4.467	0.460611	2.979207	141.3	0.115819	0.463274
0.1413	0.017289	0.146008	5.623	0.460611	2.979207	177.8	0.115819	0.463274
0.1778	0.017289	0.146008	5.623	0.579824	2.330438	177.8	0.116941	0.467763
0.1778	0.021755	0.083429	7.079	0.579824	2.330438	223.9	0.116941	0.467763
0.2239	0.021755	0.083429	7.079	0.315606	1.16448	223.9	0.104363	0.417452
0.2239	0.027396	0.24715	8.913	0.315606	1.16448	281.8	0.104363	0.417452
0.2818	0.027396	0.24715	8.913	0.39737	4.848007	281.8	0.097688	0.390751
0.2818	0.061482	0.224779	11.22	0.39737	4.848007	354.8	0.097688	0.390751

Note: Non–rack payloads are limited to one–fourth of these values



Note: Non–Rack Payloads are limited to one–fourth of this limit.

FIGURE 3.1.2.2–2 NON–ARIS TO ARIS ACCELERATION LIMIT ALTERNATIVE TO FORCE LIMITS

TABLE 3.1.2.2–2 NON–ARIS INTEGRATED RACK TO ARIS ACCELERATION LIMIT ALTERNATIVE TO FORCE LIMITS

Freq	Accel Limit (ug)	Freq	Accel Limit (ug)	Freq	Accel Limit (ug)
0.0089	0.159	0.226	5.18	5.74	2746
0.0112	0.159	0.285	5.18	7.23	2746
0.0112	0.185	0.285	8.19	7.23	4026
0.0141	0.185	0.359	8.19	9.11	4026
0.0141	0.213	0.359	12.97	9.11	5758
0.0178	0.213	0.452	12.97	11.48	5758
0.0178	0.244	0.452	20.53	11.48	8021
0.0224	0.244	0.570	20.53	14.47	8021
0.0224	0.281	0.570	32.49	14.47	10898
0.0283	0.281	0.718	32.49	18.23	10898
0.0283	0.325	0.718	51.42	18.23	14495
0.0356	0.325	0.904	51.42	22.96	14495
0.0356	0.383	0.904	81.33	22.96	18956
0.0449	0.383	1.139	81.33	28.93	18956
0.0449	0.458	1.139	128.51	28.93	24483
0.0565	0.458	1.435	128.51	36.45	24483
0.0565	0.556	1.435	202.73	36.45	31346
0.0712	0.556	1.808	202.73	45.93	31346
0.0712	0.682	1.808	318.99	45.93	39894
0.0897	0.682	2.278	318.99	57.87	39894
0.0897	0.843	2.278	499.90	57.87	50578
0.1130	0.843	2.871	499.90	72.91	50578
0.1130	1.322	2.871	778.69	72.91	63958
0.1424	1.322	3.617	778.69	91.86	63958
0.1424	2.079	3.617	1202.18	91.86	80751
0.1794	2.079	4.557	1202.18	100.00	80751
0.1794	3.280	4.557	1832.55	300.00	80751
0.2260	3.280	5.741	1832.55		

Note: Non–rack payloads are limited to one–fourth of these values

3.1.2.3 TRANSIENT REQUIREMENTS

A. Integrated racks shall limit force applied to the ISS over any ten second period to an impulse of no greater than 10 lb–s (44.5 N–s). Non–rack payloads shall limit force applied to the ISS over any ten second period to an impulse of no greater than 2.5 lb–s (11.1 N–s).

B. Integrated racks and non–rack payloads shall limit their peak force applied to the ISS to less than 1000 lb (4448 N) for any duration.

NOTE: Meeting the transient requirements of both A and B does not obviate the need to also meet the 100 second vibration requirement of 3.1.2.2 for vibration included in and following the transient disturbance.

3.1.2.4 MICROGRAVITY ENVIRONMENT

Refer to the Pressurized Payload Accommodation Handbook (PAH), SSP 57020 for microgravity environment data.

3.1.2.5 ARIS RACK VIBRATORY REQUIREMENT

ARIS Rack vibration induced by payloads shall not exceed the on–board to off–board vibration force limit of Figure 3.1.2.5–1 during microgravity periods, considering ARIS suspended rack structural dynamics and control system interaction, while ARIS is actively isolating.

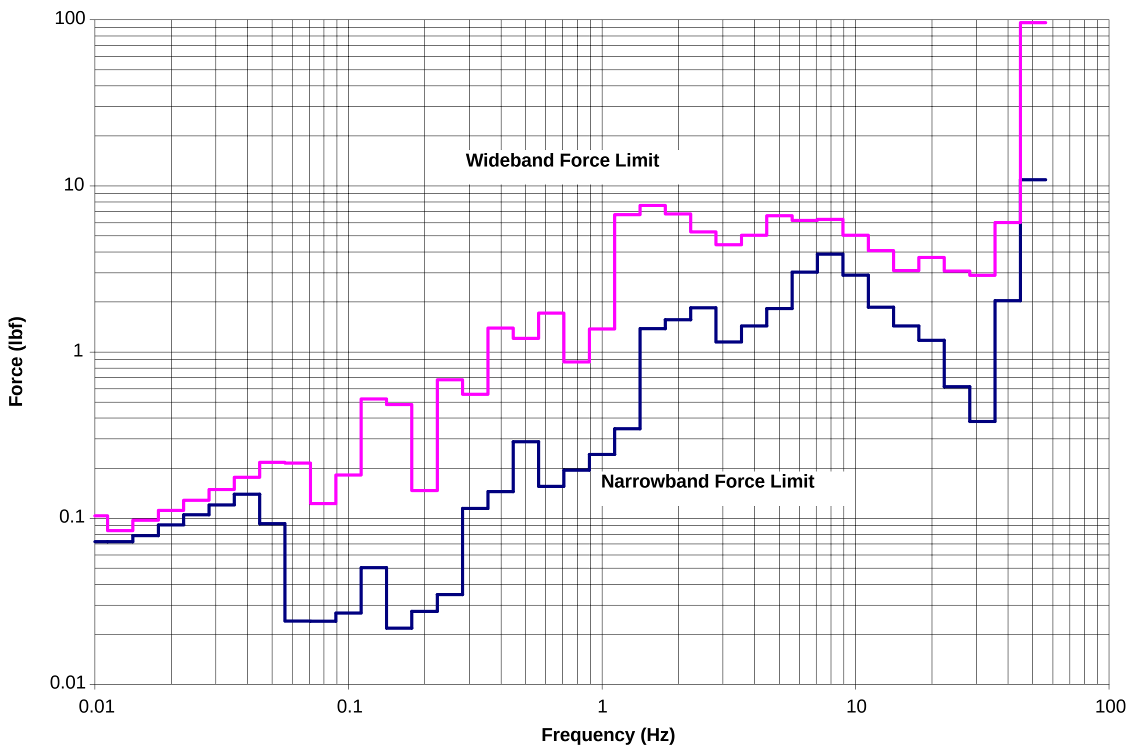


FIGURE 3.1.2.5–1 ALLOWABLE ON–BOARD FORCE VALUES FOR ARIS INTEGRATED PAYLOADS TO MEET OFF–BOARD LIMITS

TABLE 3.1.2.5–1 ALLOWABLE ON–BOARD FORCE VALUES FOR ARIS INTEGRATED PAYLOADS TO MEET OFF–BOARD LIMITS

Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)
0.0089	0.0722	0.1033
0.0112	0.0722	0.1033
0.0112	0.0722	0.0842
0.0141	0.0722	0.0842
0.0141	0.0785	0.0971
0.0178	0.0785	0.0971
0.0178	0.0910	0.1113
0.0224	0.0910	0.1113
0.0224	0.1046	0.1279
0.0282	0.1046	0.1279
0.0282	0.1201	0.1488
0.0355	0.1201	0.1488
0.0355	0.1392	0.1763
0.0447	0.1392	0.1763
0.0447	0.0926	0.2167
0.0562	0.0926	0.2167
0.0562	0.0240	0.2147
0.0708	0.0240	0.2147
0.0708	0.0240	0.1225
0.0891	0.0240	0.1225
0.0891	0.0269	0.1820
0.1122	0.0269	0.1820
0.1122	0.0502	0.5226
0.1413	0.0502	0.5226
0.1413	0.0218	0.4830
0.1778	0.0218	0.4830

Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)
0.1778	0.0274	0.1466
0.2239	0.0274	0.1466
0.2239	0.0346	0.6819
0.2818	0.0346	0.6819
0.2818	0.1147	0.5577
0.3548	0.1147	0.5577
0.3548	0.1445	1.3967
0.4467	0.1445	1.3967
0.4467	0.2881	1.2088
0.5623	0.2881	1.2088
0.5623	0.1554	1.7174
0.7079	0.1554	1.7174
0.7079	0.1945	0.8709
0.8913	0.1945	0.8709
0.8913	0.2416	1.3743
1.1220	0.2416	1.3743
1.1220	0.3449	6.7131
1.4130	0.3449	6.7131
1.4130	1.3847	7.6318
1.7780	1.3847	7.6318
1.7780	1.5667	6.7883
2.2390	1.5667	6.7883
2.2390	1.8464	5.2891
2.8180	1.8464	5.2891
2.8180	1.1511	4.4228
3.5480	1.1511	4.4228

Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)
3.5480	1.4337	5.0388
4.4670	1.4337	5.0388
4.4670	1.8234	6.6213
5.6230	1.8234	6.6213
5.6230	3.0271	6.2002
7.0790	3.0271	6.2002
7.0790	3.8832	6.2891
8.9130	3.8832	6.2891
8.9130	2.9020	5.0388
11.2200	2.9020	5.0388
11.2200	1.8602	4.0770
14.1300	1.8602	4.0770
14.1300	1.4350	3.0919
17.7800	1.4350	3.0919
17.7800	1.1754	3.7060
22.3900	1.1754	3.7060
22.3900	0.6179	3.0764
28.1800	0.6179	3.0764
28.1800	0.3821	2.9013
35.4800	0.3821	2.9013
35.4800	2.0342	6.0143
44.6700	2.0342	6.0143
44.6700	10.9057	96.2593
56.2300	10.9057	96.2593

3.1.2.6 ANGULAR MOMENTUM LIMITS

This requirement applies only to payload disturbance forces and moments which generate pure internal angular momentum impulse greater than 100 ft–lb–sec (135 N–m–sec) or a maximum impulse greater than 1.1 lb–s (5.2 N–s) over any continuous period of 9 minutes.

The following general requirements apply to the determination of applicability as stated above and to the evaluation of the ability of payloads to meet the limits of 3.1.2.6.1 and 3.1.2.6.2:

A. It is not necessary to consider transient or cyclic angular momentum changes that exceed limits over shorter intervals than the specified continuous duration if the cumulative angular momentum impulse limit is not exceeded by the end of the specified continuous duration.

B. The beginning and end times of continuous periods may be arranged in any order, as long as all periods of operation are covered in one or more continuous period. This permits start–ups followed by stopping actions within any 9 minute window to be considered as cancelled angular impulse.

C. Shorter duration angular momentum impulse sources are covered by the microgravity transient and vibratory force limits, assuming standard ISPR attachment point separation distances.

D. Payloads are not required to report angular momentum changes or forces resulting from the use of standard ISS resources such as the Vacuum Resource System or Waste Gas System.

E. If the disturbance source produces translational forces, the disturbance torque due to the disturbance force will be calculated using the moment arm from the point of application of the force to the ISS Assembly Complete configuration center of mass. The location of the Assembly Complete configuration center of mass is specified in JSC 26557, the ISS On–Orbit Assembly, Modeling and Mass Properties Databook.

F. If the disturbance source produces forces and moments, the disturbance moment due to the disturbance force will be added to the induced pure moments.

G. The locations of pure moments do not need to be reported.

3.1.2.6.1 LIMIT DISTURBANCE INDUCED ISS ATTITUDE RATE

When the on–orbit Space Station is in the microgravity mode, any nontransitory disturbance induced on the on–orbit Space Station by an individual disturbance source of a payload shall have an angular momentum impulse of less than the per axis values shown in Table 3.1.2.6–1 during any continuous nine minute period. Over no interval of time of 10 seconds or less shall a payload angular momentum impulse exceed 250 ft–lb–s (340 N–m–s), and over no interval of time of 2 minutes or less shall a payload angular momentum impulse exceed 2900 ft–lb–s (3930 N–m–s). Angular momentum impulse due to gyroscopic moments (the cross–produce of ISS orbital rate with payload angular momentum) may be excluded from these limits if the payload gyroscopic moment does not exceed 6–ft–lb (8.14 N–m).

3.1.2.6.2 LIMIT DISTURBANCE INDUCED CMG MOMENTUM USAGE

When the on–orbit Space Station is in the microgravity mode, any disturbance induced on the on–orbit Space Station by an individual disturbance source of a payload shall have an angular momentum impulse that produces an estimated Control Moment Gyroscope (CMG) momentum magnitude less than 10,000 ft–lb–sec (13,577 N–m–sec) during any continuous 110 minute period when evaluated per expression in Table 3.1.2.6–2. Angular momentum impulse due to gyroscopic moments (the cross–product of ISS orbital rate with payload angular momentum) may be excluded from these limits if the payload gyroscopic moment does not exceed 6 ft–lb (8.14 N–m).

TABLE 3.1.2.6–1 MAXIMUM ANGULAR MOMENTUM IMPULSE

Axis	Hx	Hy	Hz
ft–lb–sec	930	1277	2876
N–m–sec	1261	1732	3900

Note:
(1) Where Hx, Hy, and Hz are the x, y, and z components of the disturbance angular momentum relative to the coordinate system specified in SSP 30219, Figure 4.0–3.

TABLE 3.1.2.6–2 CMG MOMENTUM USAGE CALCULATION

Estimated CMG Momentum Usage	
ft–lb–sec	SQRT((1.25*Hx+1069)**2 + (1.25*Hy+6885)**2 + (1.25*Hz+779)**2) <10,000
N–m–sec	SQRT((1.25*Hx+1449)**2 + (1.25*Hy+9334)**2 + (1.25*Hz+1056)**2) <13,577

Notes:
(1) Where Hx, Hy, and Hz are the x, y, and z components of the disturbance angular momentum impulse using the coordinate system specified in SSP 30219, Figure 4.0–3.
(2) Where 1069, 6885, and 779 ft–lb–sec (and 1449, 9334, and 1056 N–m–sec) are the x, y, and z components, respectively, of the CMG angular momentum allocation for environmental disturbances.

3.1.3 STOWAGE

Stowage interface information is provided in SSP 50467, ISS Cargo Stowage Technical Manual: Pressurized Volume.

3.2 ELECTRICAL INTERFACE REQUIREMENTS

3.2.1 ELECTRICAL POWER CHARACTERISTICS

Electrical power characteristics are specified in this section for two interfaces, Interfaces B and C, as depicted in Figure 3.2.1–1, Electrical Power System Interface Locations. Integrated racks, payload associated hardware and payload hardware connected to Utility Outlet Panels (UOPs) in the USL, JEM, and CAM or the Standard Utility Panels (SUP) in the APM are required to be compatible with the prescribed characteristics of the Electrical Power System (EPS). For purposes of this specification, compatibility is defined as operating without producing an unsafe condition or one that could result in damage to ISS equipment or payload hardware.

3.2.1.1 STEADY-STATE VOLTAGE CHARACTERISTICS

3.2.1.1.1 INTERFACE B

The Electrical Power Consuming Equipment (EPCE) at Interface B shall operate and be compatible with the steady-state voltage limits of 116 to 126 Vdc.

3.2.1.1.2 INTERFACE C

The EPCE at Interface C shall operate and be compatible with the steady-state voltage limits of 113 to 126 Vdc.

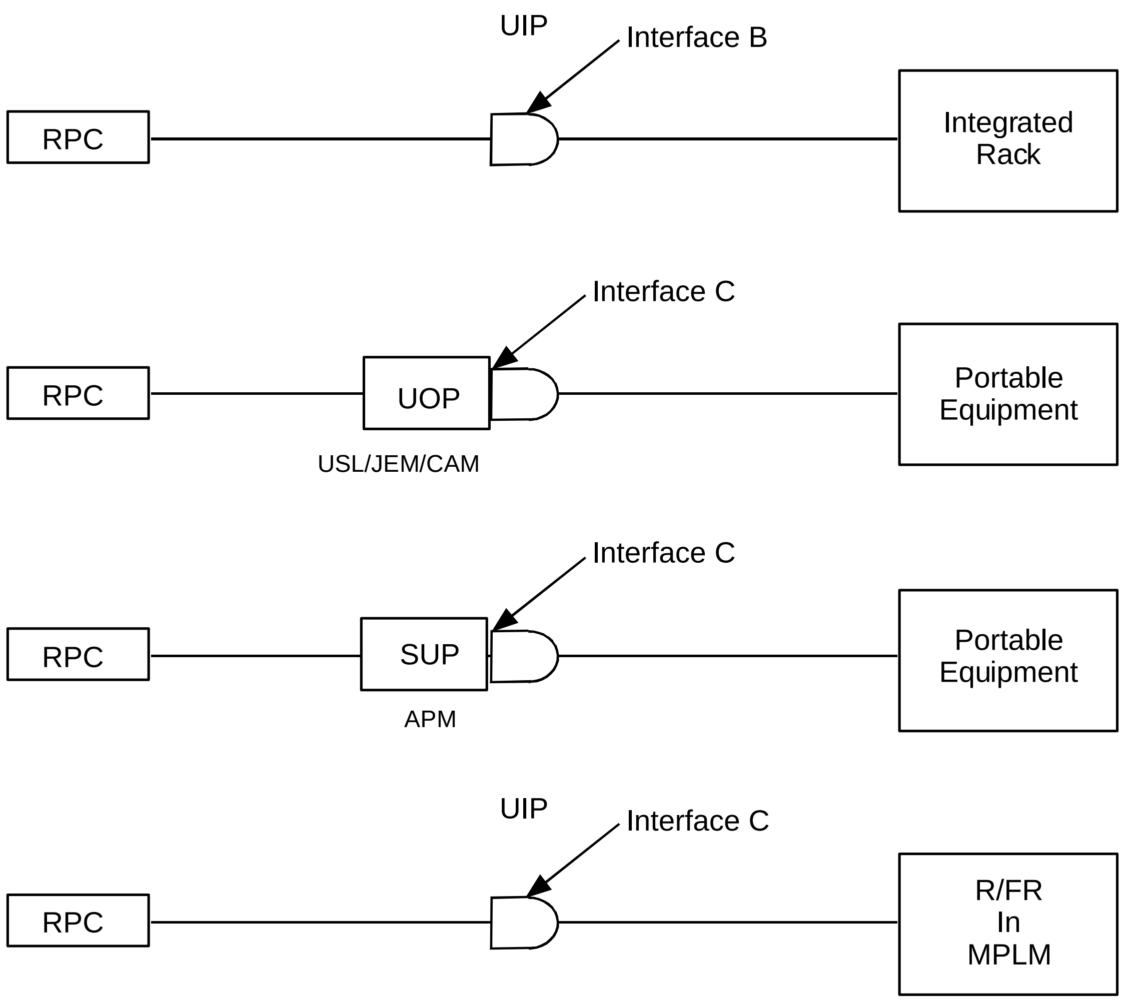


FIGURE 3.2.1–1 ELECTRICAL POWER INTERFACE LOCATIONS

3.2.1.2 RIPPLE VOLTAGE CHARACTERISTICS

3.2.1.2.1 RIPPLE VOLTAGE AND NOISE

The Integrated rack connected to Interface B and EPCE (or Integrated rack in MPLM) connected to Interface C shall operate and be compatible with the EPS time domain ripple voltage and noise level of 2.5 Vrms maximum within the frequency range of 30 Hz to 10k Hz.

3.2.1.2.2 RIPPLE VOLTAGE SPECTRUM

The Integrated rack connected to Interface B and EPCE (or Integrated rack in MPLM) connected to Interface C shall operate and be compatible with the EPS ripple voltage spectrum as shown in Figure 3.2.1.2.2–1.

Note: This limit is 6 dB below the EMC CS-01, CS–02 requirement in SSP 30237 up to 30 MHz.

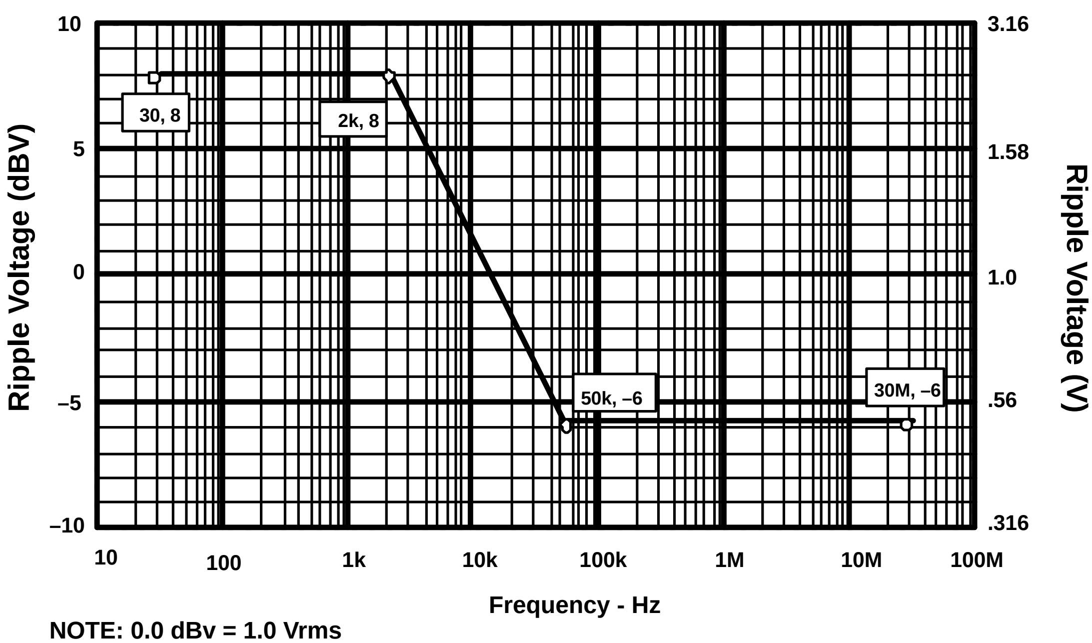


FIGURE 3.2.1.2.2–1 MAXIMUM INTERFACES B AND C RIPPLE VOLTAGE SPECTRUM

3.2.1.3 TRANSIENT VOLTAGES

3.2.1.3.1 INTERFACE B

The EPCE at Interface B shall operate and be compatible with the limits of magnitude and duration for the voltage transients at Interface B as shown in Figure 3.2.1.3.1–1. The envelope shown in this figure applies to the transient responses exclusive of any periodic ripple and/or random noise components that may be present.

Note: APM EPS transients less than 100 microseconds are defined in COL–RQ–ESA–014, paragraphs 4.1.5.3 and 4.1.7.2 (in compliance with CS06 requiring a 10 ms pulse injection). Payloads meeting CS06 requirements in SSP 30237 are in compliance with the APM requirements.

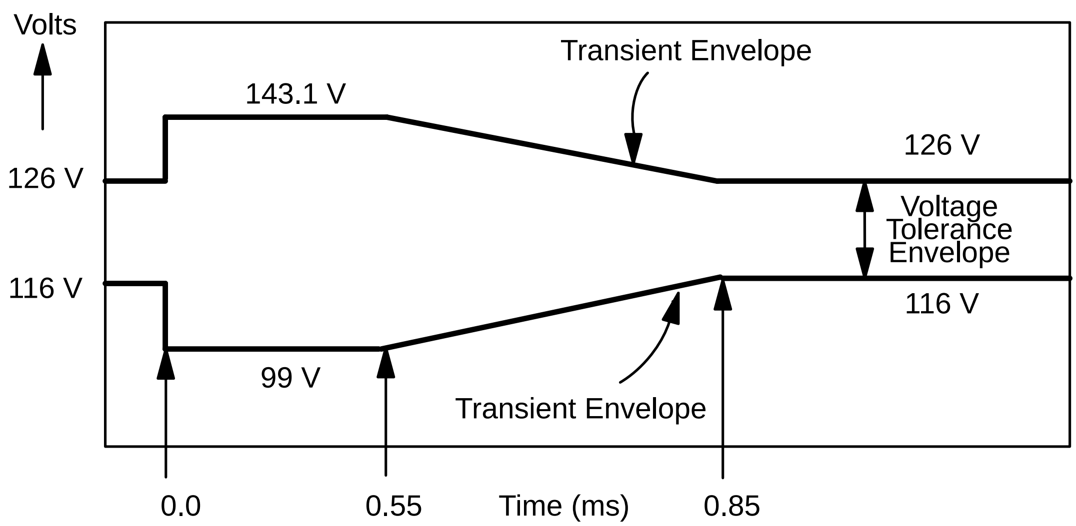


FIGURE 3.2.1.3.1–1 INTERFACE B VOLTAGE TRANSIENTS

3.2.1.3.2 INTERFACE C

The EPCE at Interface C shall operate and be compatible with the limits of magnitude and duration for the voltage transients at Interface C as shown in Figure 3.2.1.3.2–1. The envelope shown in this figure applies to the transient responses exclusive of any periodic ripple or noise components that may be present.

Note: APM EPS transients less than 100 microseconds are defined in COL–RQ–ESA–014, paragraphs 4.1.5.3 and 4.1.7.2 (in compliance with CS06 requiring a 10 ms pulse injection). Payloads meeting CS06 requirements in SSP 30237 are in compliance with the APM requirements.

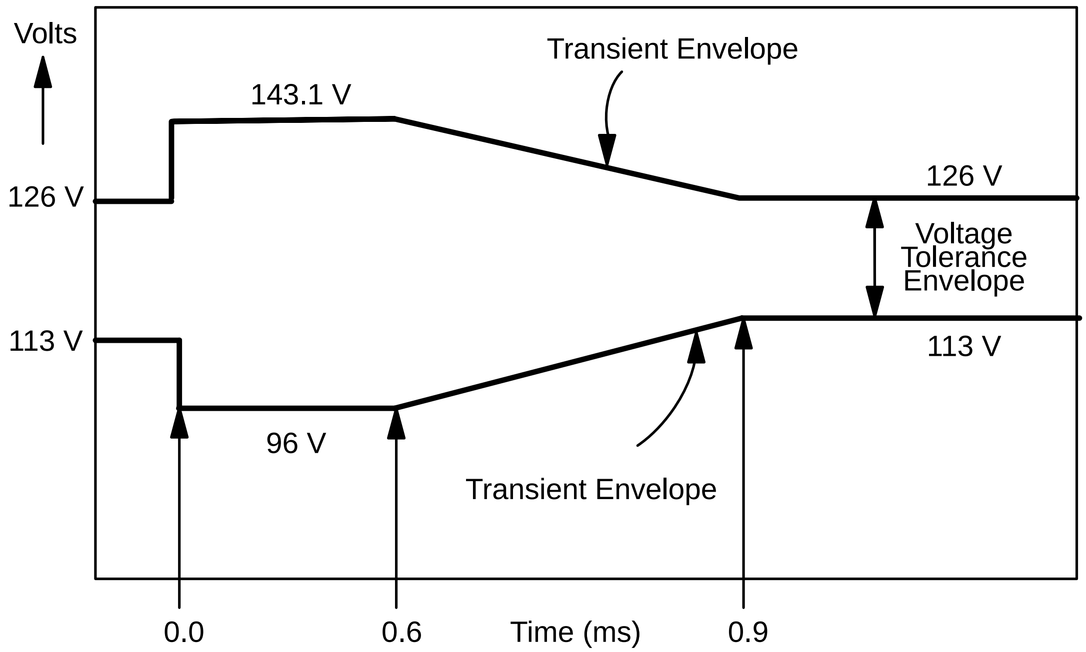
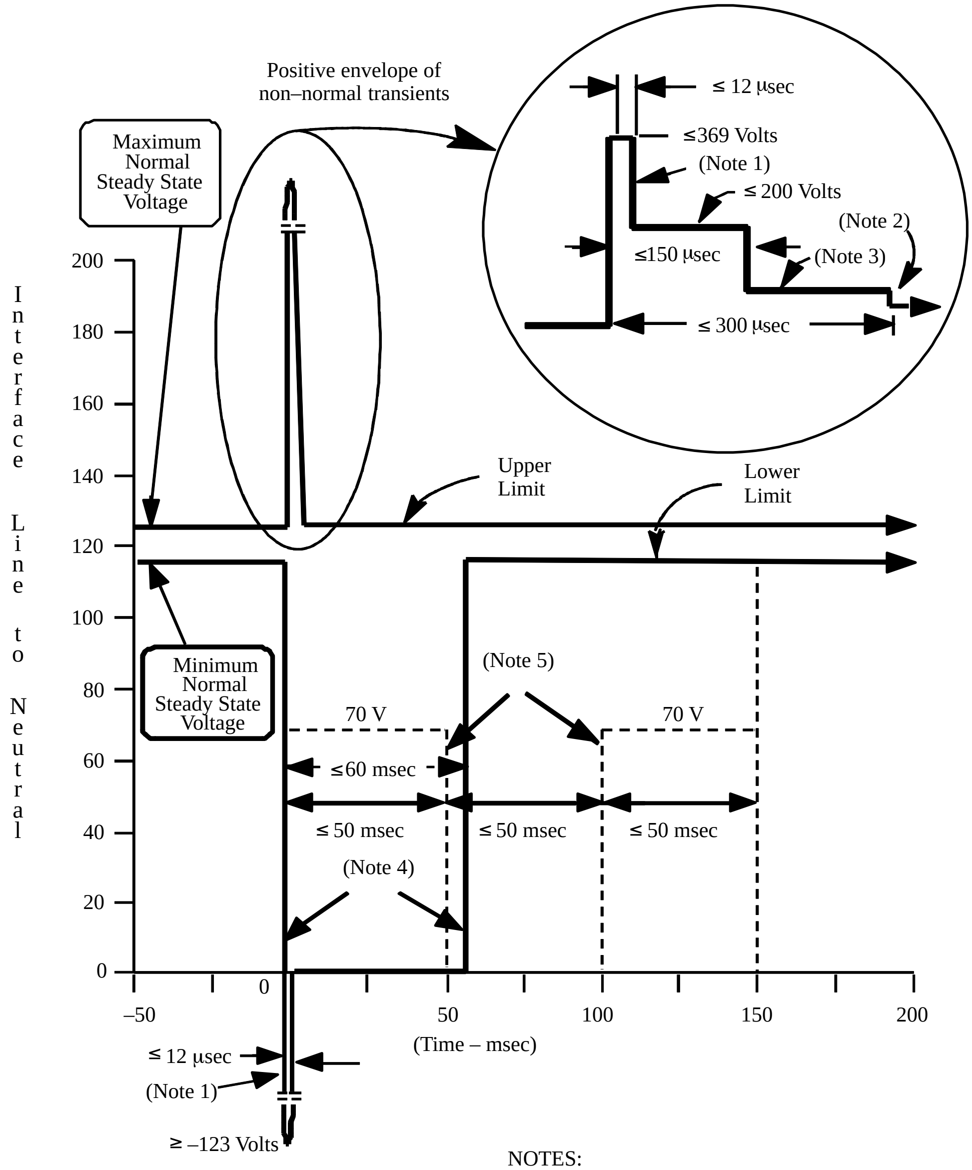
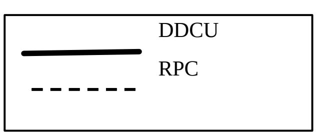


FIGURE 3.2.1.3.2–1 INTERFACE C VOLTAGE TRANSIENTS

3.2.1.3.3 FAULT CLEARING AND PROTECTION

The EPCE connected to either Interface B or Interface C shall be safe and not suffer damage with the transient voltage conditions that are within the limits shown in Figure 3.2.1.3.3–1. Loads may be exposed to transient overvoltage conditions during operation of the power system’s fault protection components.





NOTES:

1. The same as the EMC CS–06 Spike, per SSP 30237.
2. Upper limit returns to the Normal Transient Limit.
3. 156 Volts at Interface B; 157 Volts at Interface C.
4. Voltage drop-out (primary power converter in current limiting due to fault clearing).
5. Lower voltage limit when RPCM detects and responds to under voltage conditions.

FIGURE 3.2.1.3.3–1 FAULT CLEARING AND PROTECTION TRANSIENT LIMITS

3.2.1.3.4 NON-NORMAL VOLTAGE RANGE

The Integrated rack connected to Interface B and EPCE connected to Interface C shall not produce an unsafe condition or one that could result in damage to ISS equipment or payload hardware with the following non-normal voltage characteristics:

A. Maximum overvoltage of + 165 Vdc for 10 sec.

B. Undervoltage conditions of + 102 Vdc for an indefinite period of time.

3.2.2 ELECTRICAL POWER INTERFACE

3.2.2.1 UIP, UOP AND SUP CONNECTORS AND PIN ASSIGNMENTS

A. Integrated rack connectors P1 and P2 mating requirements to the UIP connectors J1 and J2 are specified in Table 3.1.1.6.1–1, A and B.

B. Integrated rack connectors P1 and P2 shall meet the pin out interfaces of the UIP connectors J1 and J2 as specified in SSP 57001, paragraph 3.2.1.1.

C. Integrated rack connectors P1 and P2 shall meet the requirements of SSQ 21635 or equivalent.

D. EPCE connectors P3 and P4 mating requirements to the UOP connectors J3 and J4 are specified in Table 3.1.1.6.1–1, X, Y, and Z.

E. EPCE connectors P3 and P4 shall meet the pin out interfaces of the UOP connectors J3 and J4 as specified in SSP 57001, paragraph 3.2.1.2.

F. EPCE connectors P3 and P4 to UOP shall meet the requirements of SSQ 21635 or equivalent.

G. EPCE connectors P1, P2 and P3 mating requirements to the SUP connectors J1, J2 and J3 are specified in Table 3.1.1.6.1–1, AA, AB and AC.

H. EPCE connectors P1, P2 and P3 shall meet the pin out interfaces of the SUP connectors J1, J2 and J3 as specified in SSP 57001, paragraph 3.2.1.3.

Note: As shown in Table 3.2.1.3–1 of SSP 57001, connector J4 is for ESA use only and connectors J5, J6, J7, J8 and J9 are not available for payload use.

I. EPCE connectors P1, P2 and P3 to SUP shall meet the requirements of SSQ 21635 or equivalent.

3.2.2.2 POWER BUS ISOLATION

A. Integrated rack locations requiring power from two independent ISS power buses shall provide a minimum of 1-megohm isolation in parallel with not more than 0.03 microfarads of mutual capacitance within internal and external rack EPCE at all times such that no single failure shall cause the independent power buses to be electrically tied. (Mutual capacitance is defined as line-to-line capacitance, exclusive of the EMI input filter.)

B. Integrated rack internal and external EPCE shall not use diodes to electrically tie together independent ISS power bus high side or return lines. These requirements apply to both supply and return lines.

ISS provides the capability to support simultaneous use of Main (J1) and Auxiliary (J2) power at each ISPR location (except MPLM). Constrained element level payload operations may occur from individual payload racks which automatically switch to or require simultaneous use of auxiliary power. ISS is required to reserve the maximum auxiliary power needed on that channelized Bus (even when not in use) to prevent Bus overload. For this reason, auxiliary power feeds will nominally be powered off by the module RPC. Specific constraints on the use of auxiliary power will be defined in the payload unique ICD.

3.2.2.3 COMPATIBILITY WITH SOFT START/STOP RPC

An integrated rack connected to Interface B or EPCE connected to Interface C shall initialize with the soft start/stop performance characteristics when power is applied, sustained, and removed by control of remote power control switches. The soft start/stop function, active only when the Remote Power Controller (RPC) is commanded on or off, is limited to 100 amps/ms, or less, by the RPC output. The response of the soft start/stop function is linear for resistive loads for 1 to 10 ms for U.S. LAB feeds, 1.5 to 5 ms for JEM 50 amp main feeds, 1.5 to 5 ms for JEM 25 amp main feeds, 0.1 to 5 ms for JEM 10 amp auxiliary feeds, and 0.1 to 50 ms for APM feeds between 10% and 90% of rated current level.

Note: Soft start/stop characteristics of U.S. standard RPCMs are shown in Figure 3.2.2.3–1.

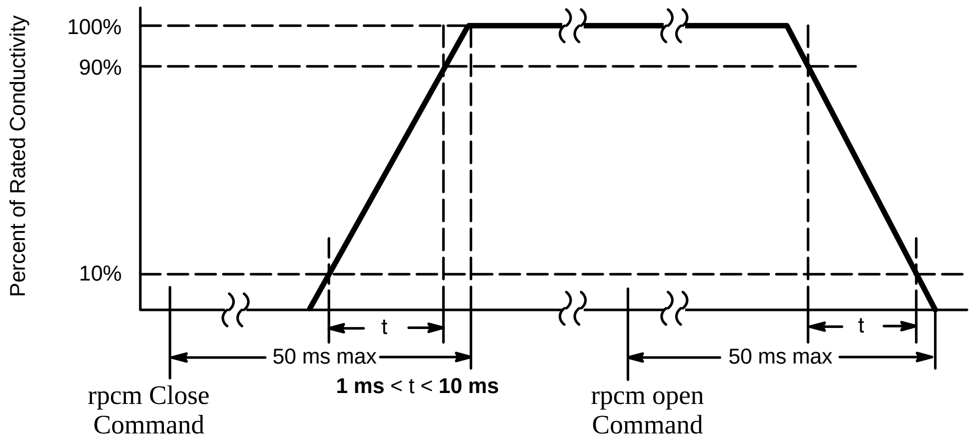
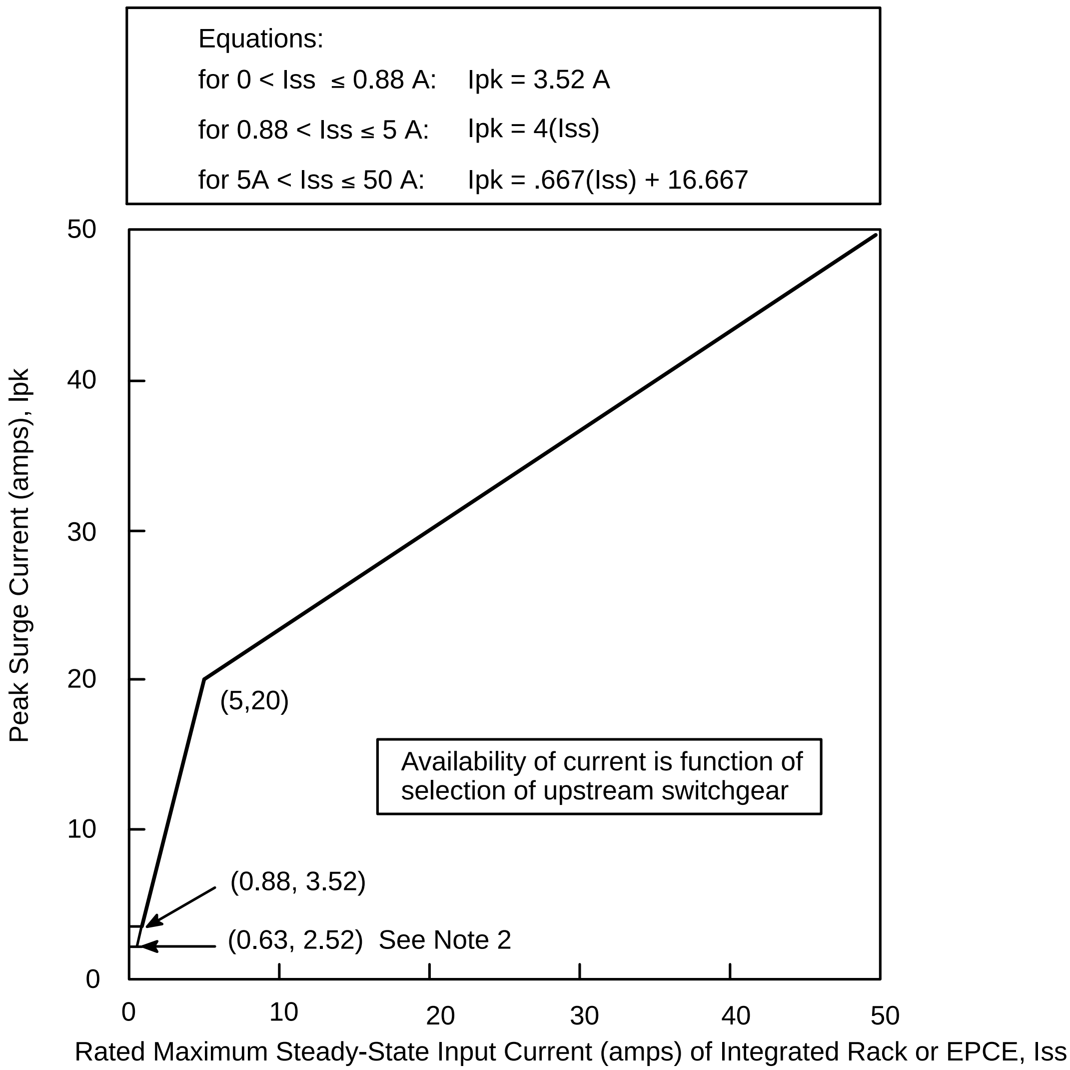


FIGURE 3.2.2.3–1 U.S. RPCM SOFT START/STOP CHARACTERISTICS

3.2.2.4 SURGE CURRENT

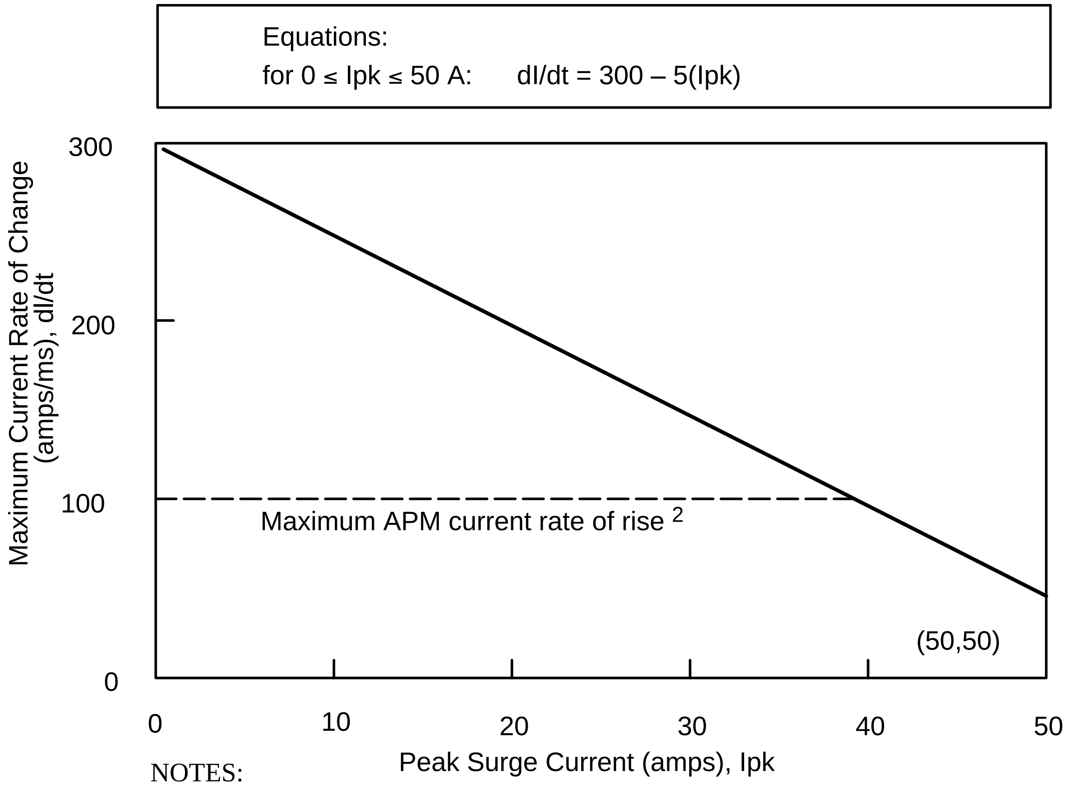
The surge current at the power input to the integrated rack connected to Interface B or EPCE connected to Interface C shall not exceed the surge current values defined in Figures 3.2.2.4–1 and 3.2.2.4–2 when powered from a voltage source with characteristics specified in paragraphs 3.2.1 and 3.2.2.3, with the exception that the source impedance is considered to be 0.1 ohm. The duration of the surge current shall not exceed 10 ms. The duration of surge current is measured as the duration in which the current exceeds the maximum steady state input current derived from the payload maximum continuous power defined in the unique hardware ICD in accordance with Table 3.2.7–1 of SSP 57001. These requirements apply to all operating modes and changes including power-up and power-down.



NOTES:

1. For transients less than 100 microseconds, refer to SSP 30237.
2. NASA Space Station equipment accommodated in JEM will have a maximum allowable peak surge current of 2.52 amps for equipment having a steady-state input no greater than 0.63 amps.

FIGURE 3.2.2.4–1 PEAK SURGE CURRENT AMPLITUDE VERSUS RATED STEADY-STATE INPUT CURRENT



NOTES:

1. For transients less than 100 microseconds, refer to SSP 30237.
2. NASA Space Station and ISPR payload equipment accommodated in APM shall function correctly with a maximum current rate of rise of 100 amps/ms up to 40-amps peak surge current.

FIGURE 3.2.2.4–2 MAXIMUM CURRENT RATE OF CHANGE VERSUS PEAK SURGE CURRENT AMPLITUDE

3.2.2.5 REVERSE CURRENT

The integrated rack electrical interface main input power and Auxiliary input power, and the EPCE electrical interface with UOP in USL and JEM, and EPCE electrical interface with SUP in APM, must comply with the requirements defined in paragraph 3.2.2.5.1 or 3.2.2.5.2 for the reverse current into the upstream power source.

Note: The integrated rack and EPCE having input connected capacitances, the aggregate total of which is less than 25 micro–farads, are considered meeting the limits of paragraph 3.2.2.5.1 for US Type I RPCMs. Input connected capacitors are those which, by virtue of circuit arrangement, are able to discharge through the power source when the power source is short circuited. Series connected rectifier diodes and resistors greater than 10 Ohms are sufficient to block such discharges.

3.2.2.5.1 REVERSE CURRENT LIMITS

The integrated rack and EPCE shall limit reverse current transients that can occur when a hard fault occurs across the power source within the applicable transient envelope shown in Figures 3.2.2.5.1–1, 3.2.2.5.1–2 and 3.2.2.5.1–3.

For purposes of this interface definition, the fault is 10 milli Ohms or less applied within 2 micro–seconds or less. For the integrated rack and EPCE exhibiting reverse current transient peaks within ±100 Amperes, the fault resistance is 40 milli Ohms or less.

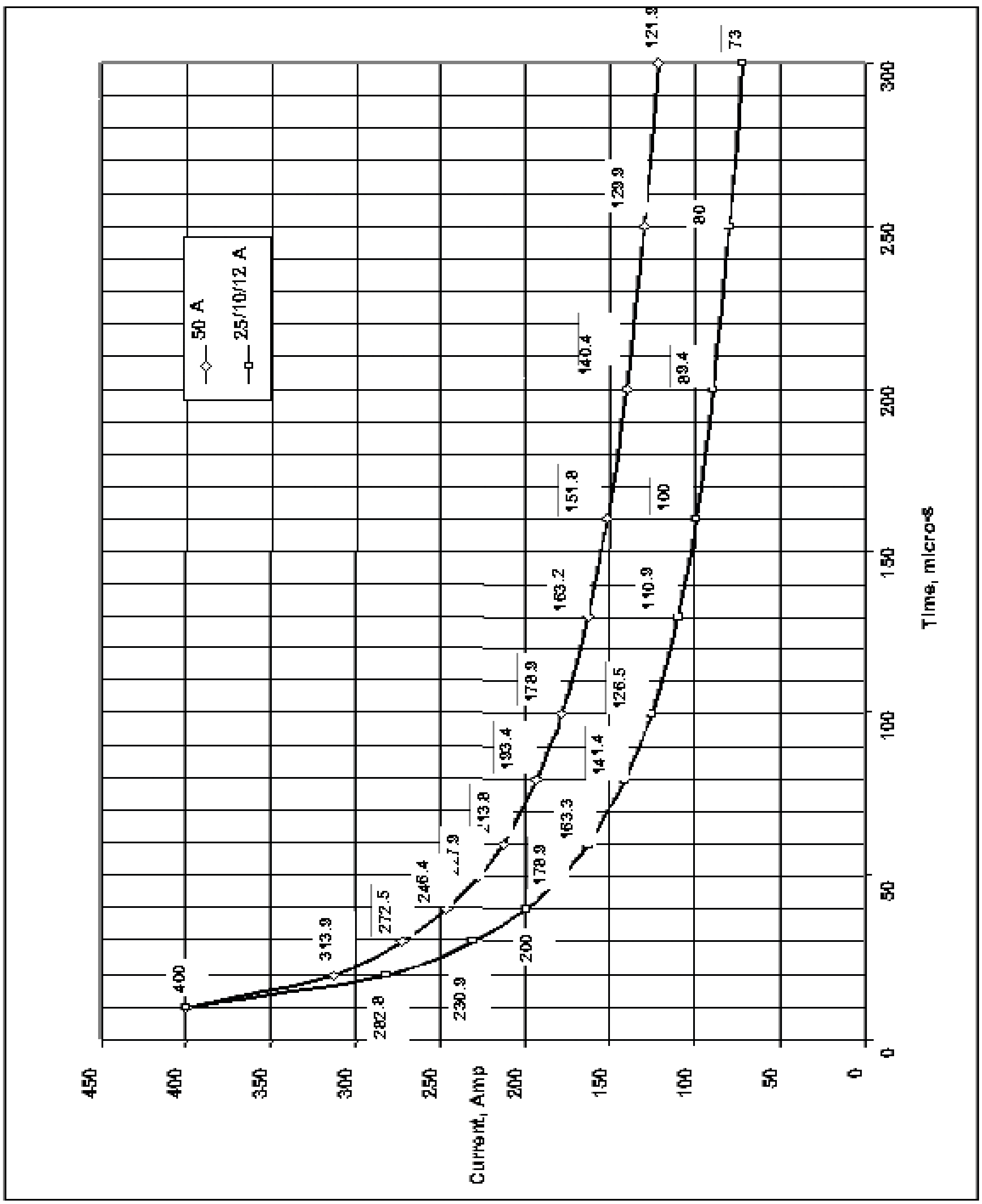


FIGURE 3.2.2.5.1–1 REVERSE CURRENT ENVELOPES FOR TIME DURATION SHORTER THAN 300 MICROSECONDS

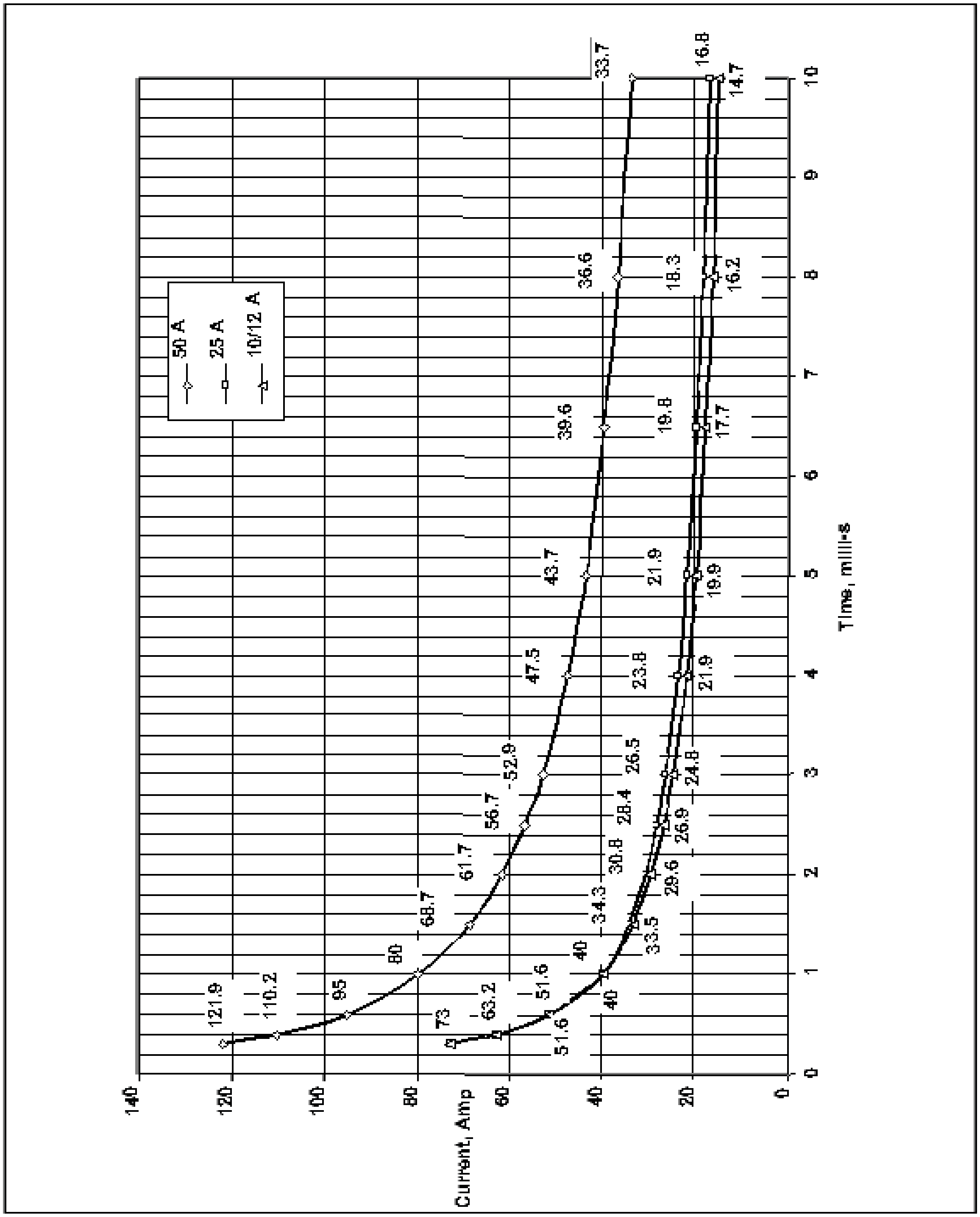


FIGURE 3.2.2.5.1–2 REVERSE CURRENT ENVELOPES FOR TIME DURATION BETWEEN 300 MICROSECONDS AND 10 MILLISECONDS

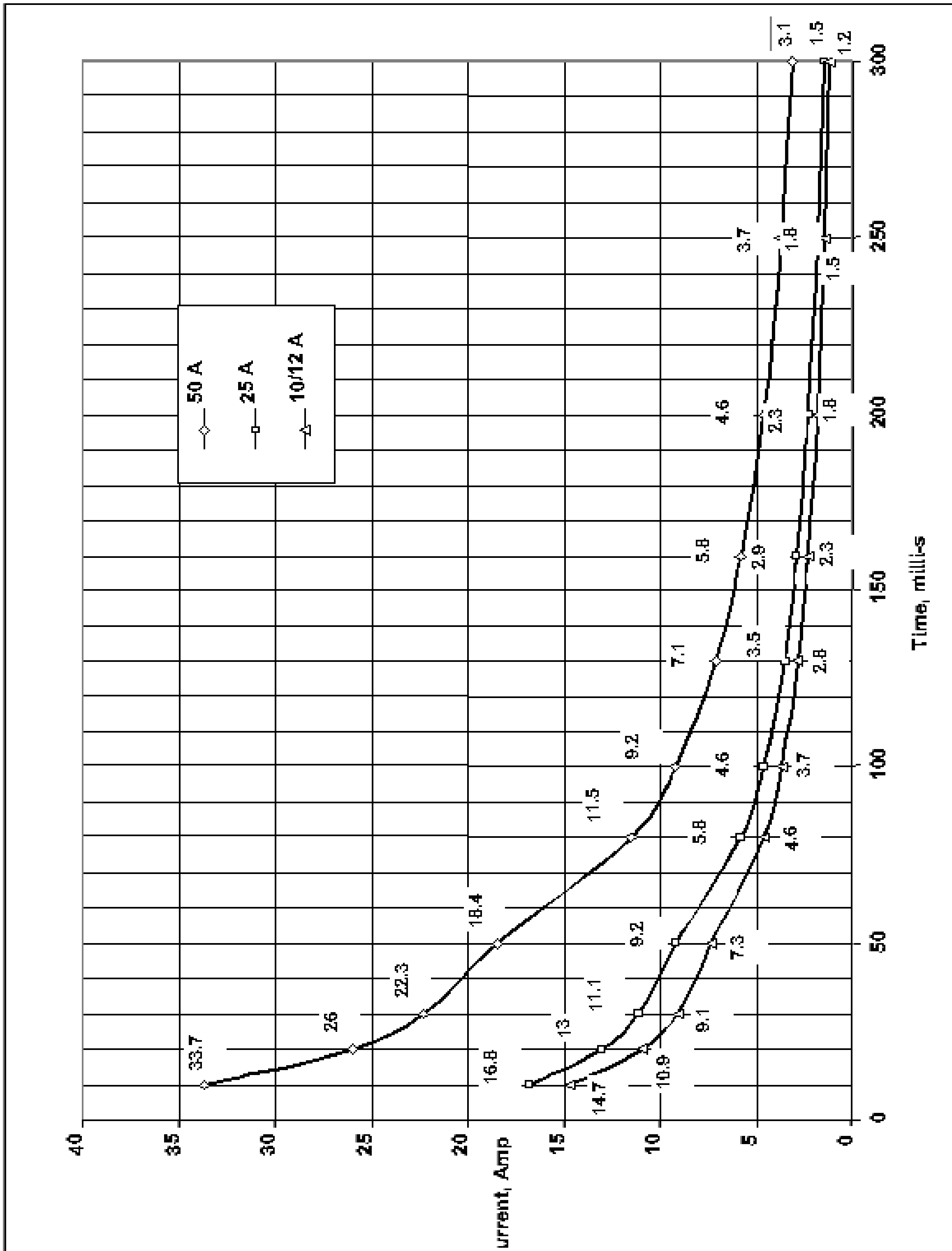


FIGURE 3.2.2.5.1–3 REVERSE CURRENT ENVELOPES FOR TIME DURATION BETWEEN 10 AND 300 MILLISECONDS

3.2.2.5.2 TRANSIENTS PARTIALLY CONTAINED WITHIN THE ENVELOPE

If the reverse current exceeds the envelope limits defined in paragraph 3.2.2.5.1 for one or more short time intervals, the transient peak current and the ratio of the times of intersection with the envelope shall satisfy the following inequality

$$\left(\frac{i_{pk}}{i_e}\right)^2 \bullet \ln\left(\frac{t_2}{t_1}\right) \leq 1$$

Where 1n represents the natural logarithm, t_1 and t_2 correspond to the beginning and end times, respectively, of each interval when the transient is outside the envelope, i_{pk} is the peak of the transient occurring between t_2 and t_1, and i_e is the point on the envelope at the time of the peak i_{pk}. For multiple intervals in which the envelope is exceeded, the left–hand side of this expression will be evaluated for each interval and the sum of all such results will total less than unity.

Note:

1. This criterion is based on approximation of the real transient by a vertical–sided pulse which begins at t_1, follows a t^2 function through i_{pk} point, and ends at t_2. This vertical–sided pulse has the stress property equivalent to the stress that the RPCMs in USL, JEM and APM can sustain.

2. An example of such a case is illustrated in Figure 3.2.2.5.2–1 where the transient for a hypothetical Load “A” is overlaid with the envelope for a US Type II RPCM, rated at 25 A. The figure shows the transient crossing the envelope at times t_1 = 5.1 ms and t_2 = 7.1 ms with a peak i_{pk} = 27.5 A and an envelope value, i_e = 21 A. Substituting these values into the left–hand side of the inequality in this paragraph leads to

   $(i_{pk} / i_e)^2$ x ln(7.1 / 5.1) = 27.5 / 21)^2 x 0.331 = 0.567

   which satisfies the inequality, and since there are no additional envelope crossings, this calculation demonstrates compatibility.

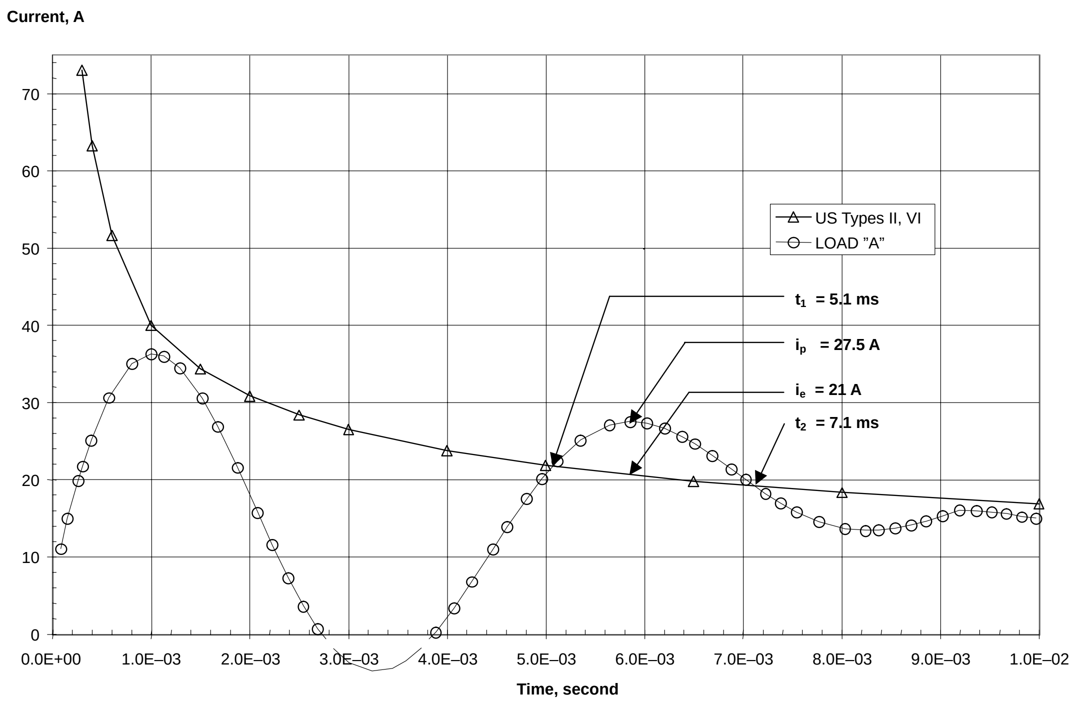


FIGURE 3.2.2.5.2–1 AN EXAMPLE OF A LOAD PARTIALLY CONTAINED WITHIN THE ENVELOPE

3.2.2.6 CIRCUIT PROTECTION DEVICES

3.2.2.6.1 ISS EPS CIRCUIT PROTECTION CHARACTERISTICS

3.2.2.6.1.1 REMOTE POWER CONTROLLERS (RPCs)

A. The Integrated rack connected to an Interface B ISPR location shall operate and be compatible with the characteristics in Figures 3.2.6–2, 3.2.6–3, and 3.2.6–4 as described in paragraph 3.2.6 located in SSP 57001.

B. The Integrated rack connected to a MPLM powered rack location shall operate and be compatible with the characteristics in Figure 3.2.6–6 as described in paragraph 3.2.6 located in SSP 57001.

C. The EPCE connected to a UOP shall operate and be compatible with the characteristics in Figure 3.2.6–5 as described in paragraph 3.2.6 located in SSP 57001.

D. Overcurrent protection shall be provided at all points in the system where power is distributed to lower level (wire size not protected by upstream circuit protection device) feeder and branch lines.

E. The Integrated rack connected to Interface B shall provide current limiting overcurrent protection for all internal loads (exclusive of overcurrent protection circuits and devices) drawing power from an Interface B power feed. For the purpose of this requirement, internal overcurrent protection circuits and devices are not considered to be loads.

3.2.2.6.2 EPCE RPC INTERFACE REQUIREMENTS

3.2.2.6.2.1 RPC TRIP COORDINATION

3.2.2.6.2.1.1 PAYLOAD TRIP RATINGS

The payload power circuit protection device in the integrated rack connected to Interface B shall be designed to provide trip coordination, i.e., the downstream circuit protection device disconnects a shorted circuit or an overloaded circuit from the upstream power interface without tripping the upstream circuit protection device. The trip coordination is achieved either by shorter trip time or lower current limitation than the upstream protection devices defined in paragraph 3.2.2.6.1.1.A.

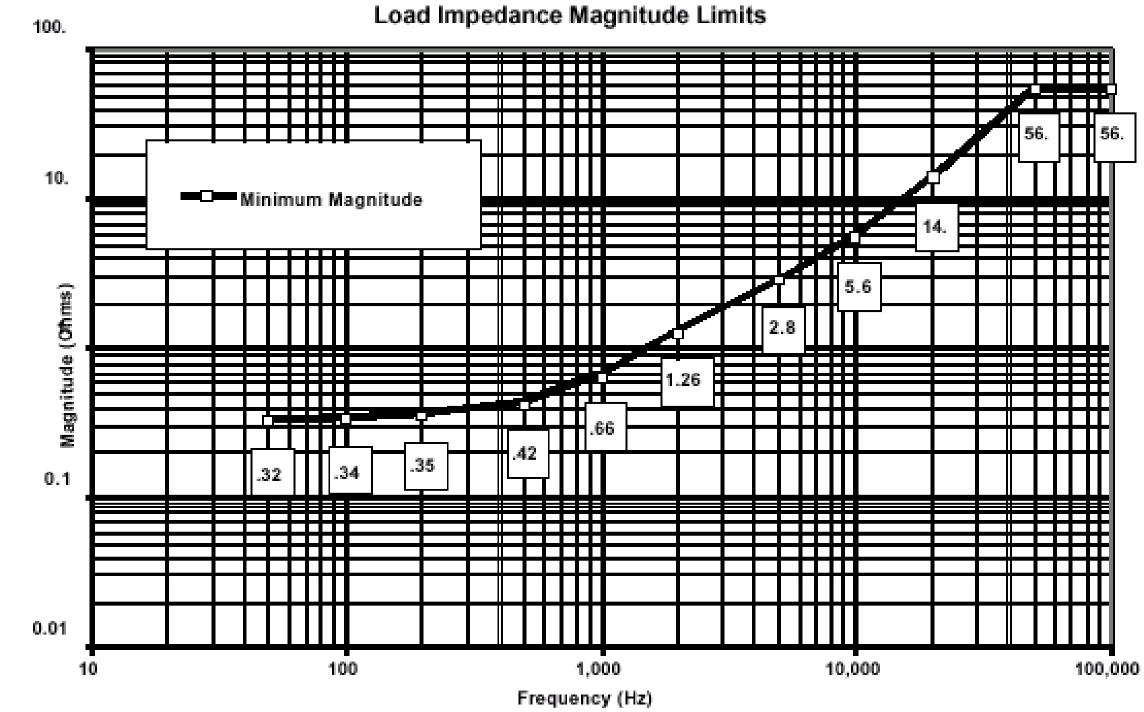
3.2.2.7 EPCE COMPLEX LOAD IMPEDANCES

3.2.2.7.1 INTERFACE B

A. The load impedance presented by the integrated rack to the Main Interface B shall not exceed the bounds defined by Figures 3.2.2.7.1–1 and 3.2.2.7.1–2 for input over the frequency range of 50 Hz to 100 kilohertz (kHz). The magnitude component of the integrated rack input impedance should not be less than the minimum defined in Figures 3.2.2.7.1–1 and 3.2.2.7.1–2. At frequencies where the magnitude component of the integrated rack input impedance is less than the defined minimum, the phase component of the input impedance shall not exceed the bounds defined in these Figures.

B. The load impedance presented by the integrated rack to the 1.2 to 1.44 kW Interface B shall not exceed the bounds defined by Figure 3.2.2.7.1–3 for input over the frequency range of 50 Hz to 100 kilohertz (kHz). The magnitude component of the integrated rack input impedance should not be less than the minimum defined in Figure 3.2.2.7.1–3. At frequencies where the magnitude component of the integrated rack input impedance is less than the defined minimum, the phase component of the input impedance shall not exceed the bounds defined in this Figure.

Note: The limits defined in Figures 3.2.2.7.1–1, 3.2.2.7.1–2 and 3.2.2.7.1–3 provide the worst–case envelope for power bus with single DDCU and power bus with two DDCU's.



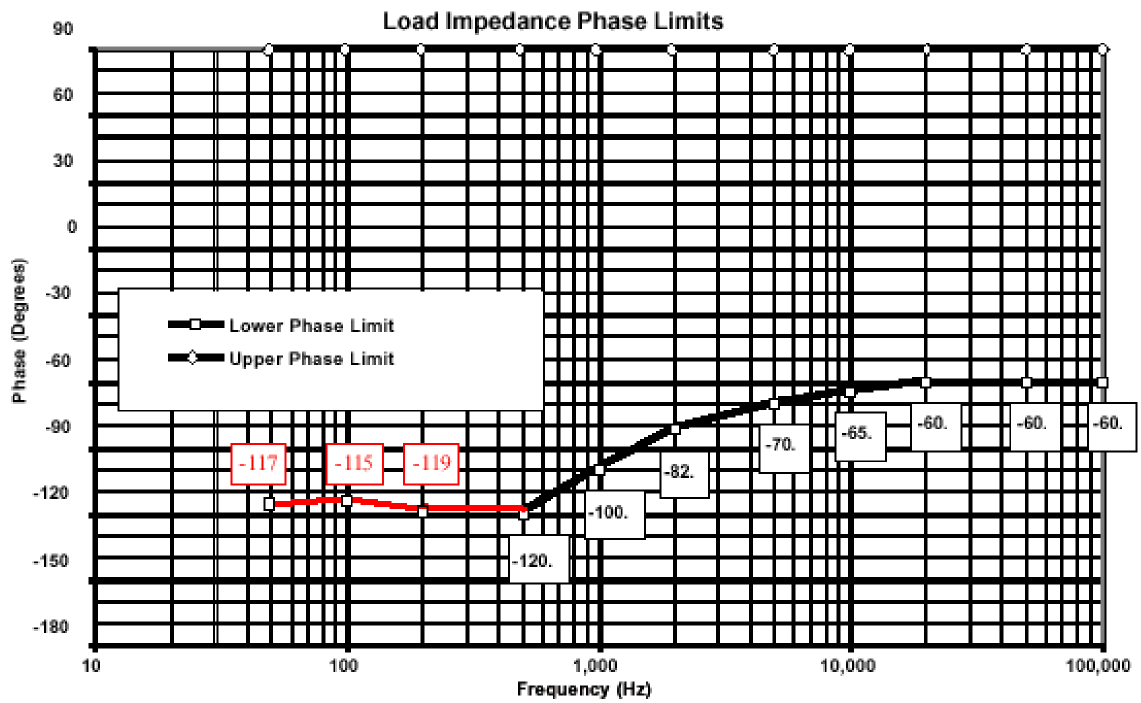


FIGURE 3.2.2.7.1–1 3KW INTERFACE B LOAD IMPEDANCE LIMITS

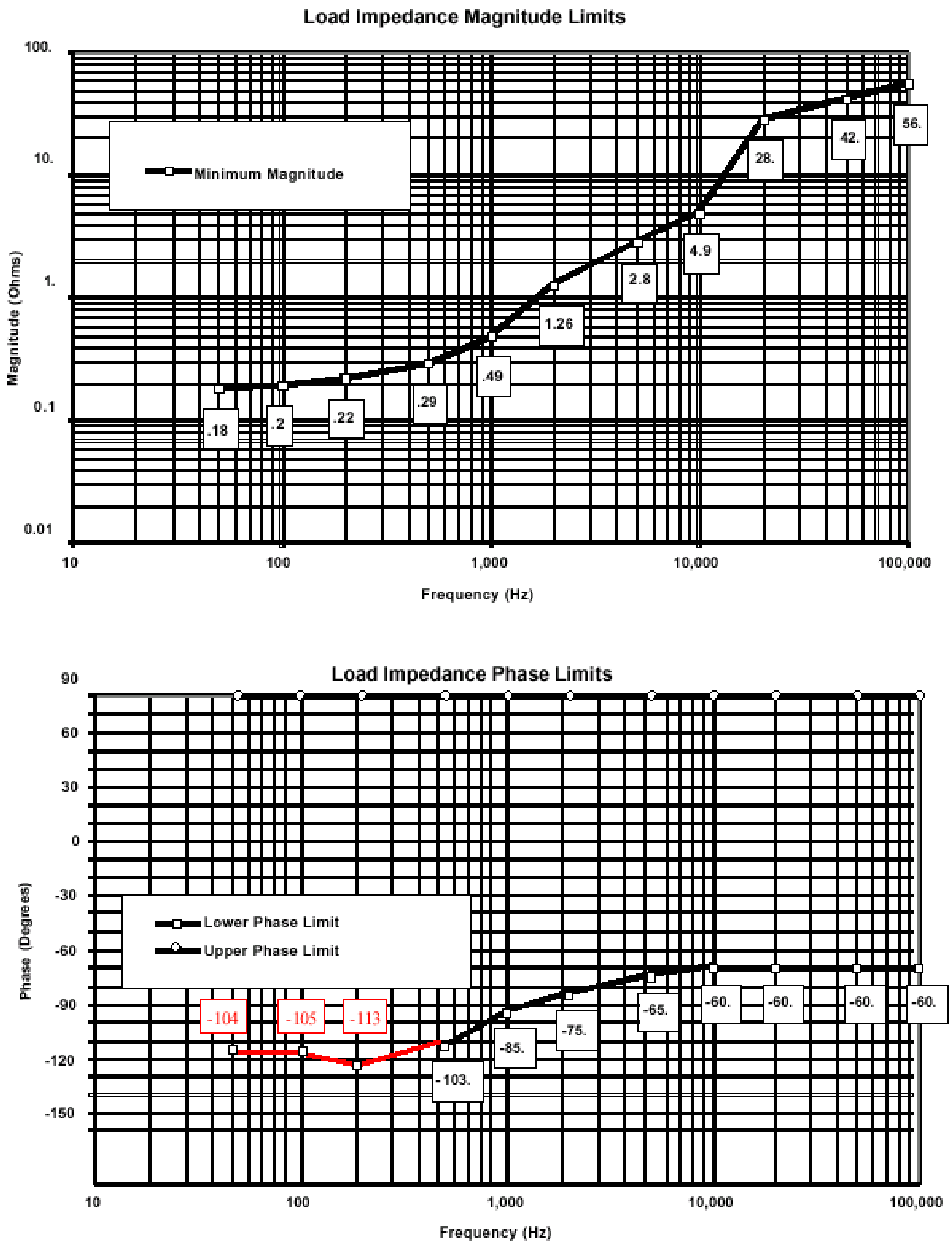


FIGURE 3.2.2.7.1–2 6KW INTERFACE B LOAD IMPEDANCE LIMITS

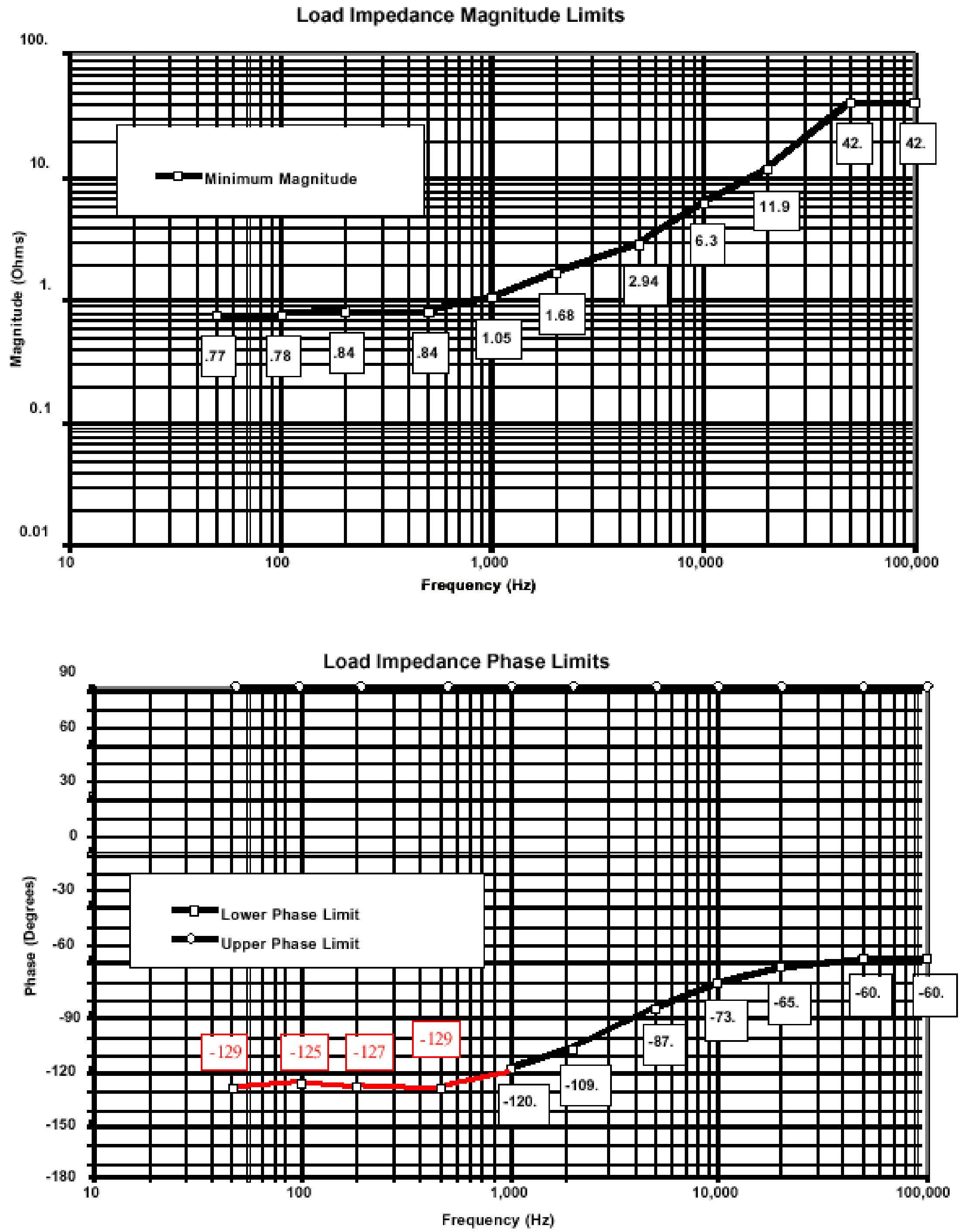


FIGURE 3.2.2.7.1–3 1.2 TO 1.44 KW AUXILIARY INTERFACE B LOAD IMPEDANCE LIMITS

3.2.2.7.2 INTERFACE C

The load impedance presented by the EPCE to Interface C shall not exceed the bounds defined by Figure 3.2.2.7.2–1 for input over the frequency range of 50 Hz to 100kHz. The magnitude component of the EPCE input impedance should not be less than the minimum defined in Figure 3.2.2.7.2–1. At frequencies where the magnitude component of the EPCE input impedance is less than the defined minimum, the phase component of the input impedance shall not exceed the bounds defined in this figure.

3.2.2.8 LARGE SIGNAL STABILITY

The integrated rack connected to Interface B and the EPCE connected to Interface C shall maintain stability with the ISS EPS interface by damping a transient response to 10 percent of the maximum response amplitude within 1.0 millisecond (ms), and remaining below 10 percent thereafter under the following conditions:

1. The rise time/fall time (between 10 and 90 percent of the amplitude) of the input voltage pulse is less than 10 microseconds (s).

2. The voltage pulse is to be varied from 100 to 150 μs in duration.

Note: Figure 3.2.2.8–1 is used to clarify the above requirement.

3.2.2.9 DELETED

3.2.2.10 ELECTRICAL LOAD-STAND ALONE STABILITY

The Integrated Rack connected to Interface B and EPCE (or Integrated rack in MPLM) connected to Interface C shall provide local stability by meeting the following conducted susceptibility requirements defined in paragraph 3.2.4.4:

A. Paragraph 3.2.2.1 of SSP 30237 (CS01)

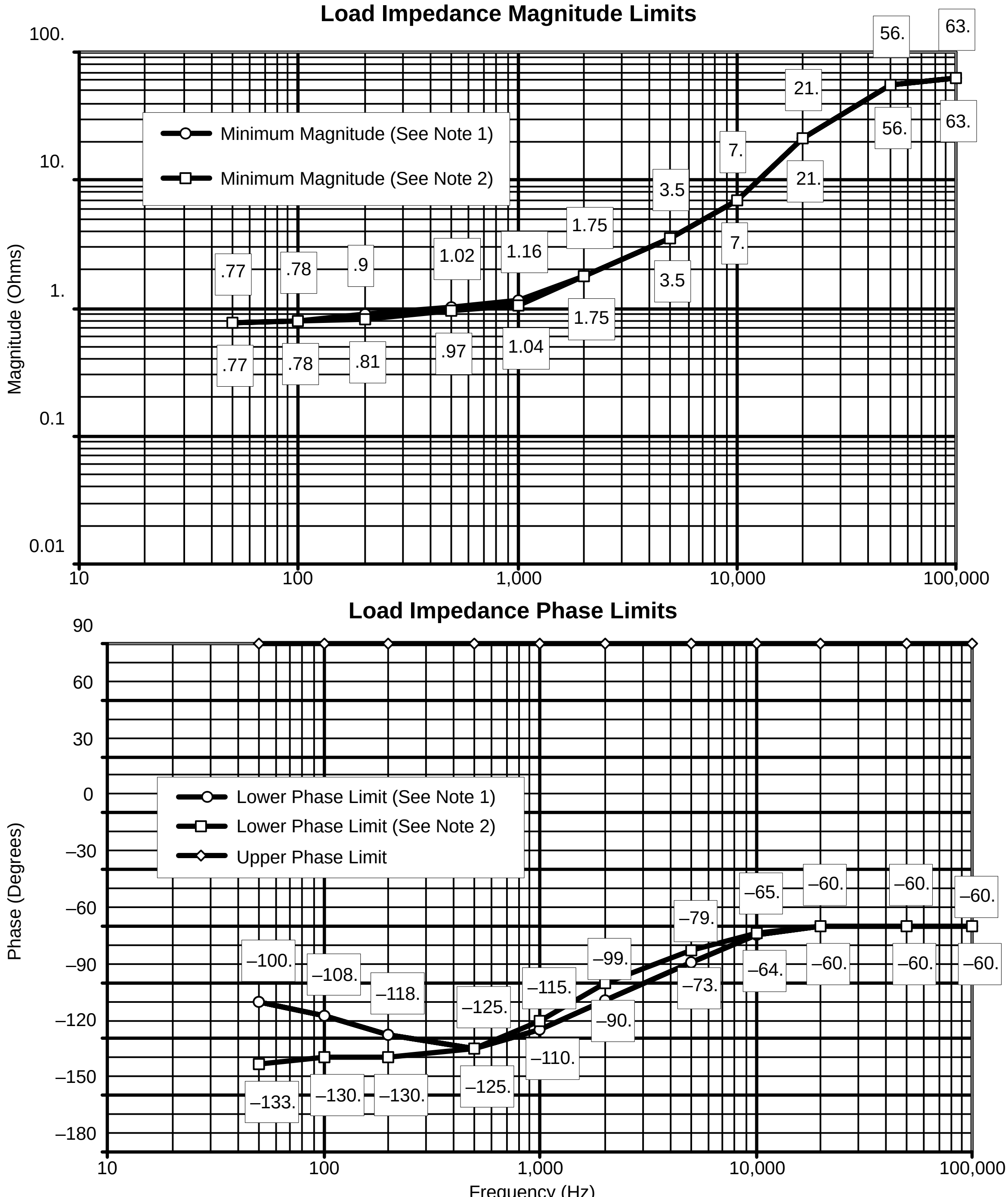
B. Paragraph 3.2.2.2 of SSP 30237 (CS02)

C. Paragraph 3.2.2.3 of SSP 30237 (CS06)

3.2.2.11 DELETED

3.2.2.12 MAXIMUM LOAD STEP SIZE

For 6 kW and 12 kW racks, step changes in power demand by the integrated rack connected to Interface B shall not exceed 3 kilowatts on a single power feed.



Notes:

1. Limit when total load on the Secondary Power Source is less than 400 watts.
2. Limit when total load on the Secondary Power Source is at least 400 watts.
3. Magnitude and phase curves apply to U.S. LAB, JEM, and COF only.

FIGURE 3.2.2.7.2–1 INTERFACE C LOAD IMPEDANCE LIMITS FOR 10 – 12 AMPERE CIRCUIT RATING

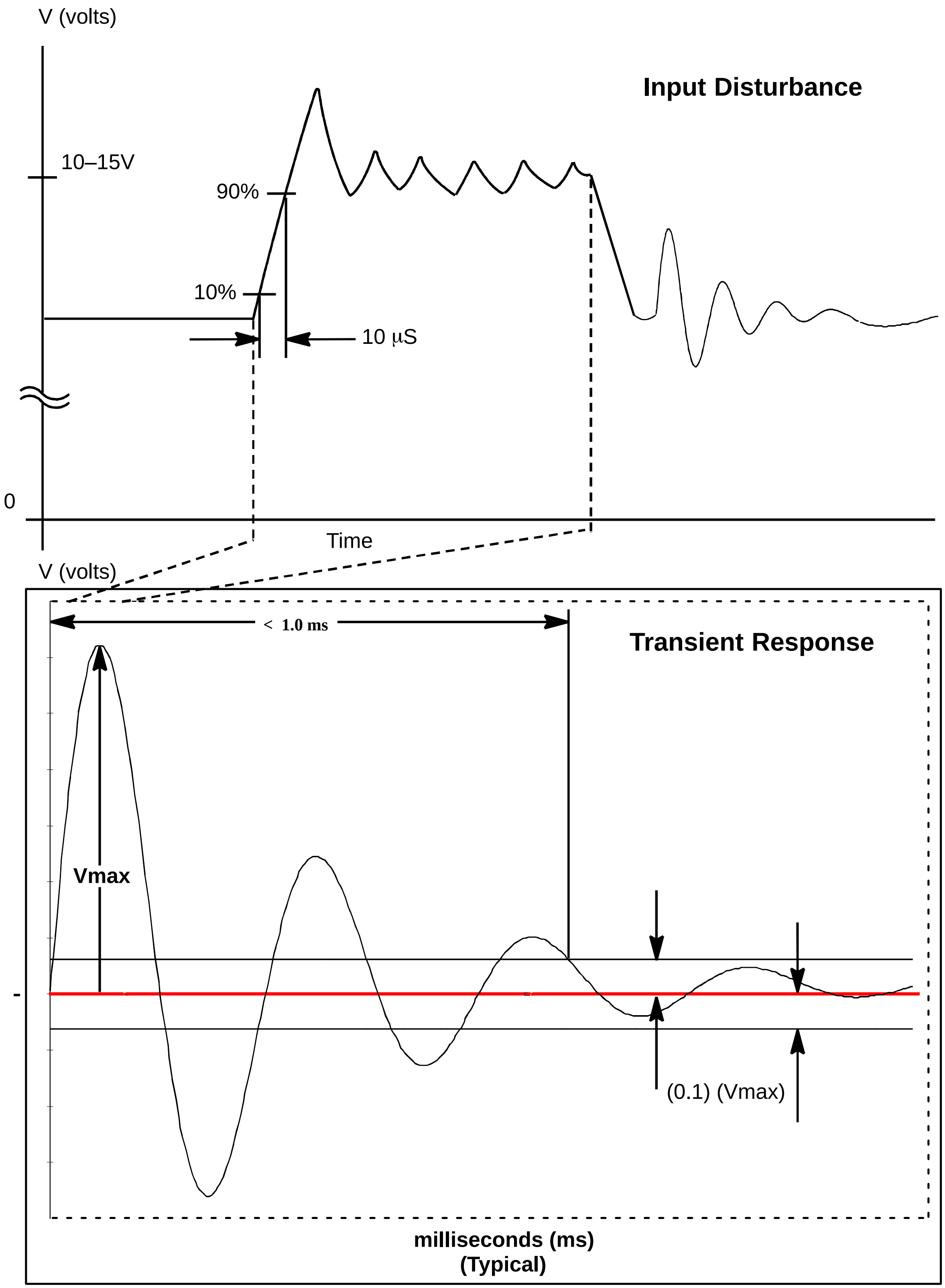


FIGURE 3.2.2.8–1 PULSE APPLIED TO THE POWER INPUT OF THE INTEGRATED RACK OR EPCE

3.2.3 ELECTRICAL POWER CONSUMER CONSTRAINTS

3.2.3.1 WIRE DERATING

A. Wire derating for wire/cable between EPCE and the UOP shall be in accordance with SSP 30312.

B. Derating criteria for EPCE at and downstream of the primary circuit protection device(s) in the integrated rack, as shown in Figure 3.2.3.1–1, shall be per NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA-92-038.

C. Integrated racks shall use 4 gauge wire for main and auxiliary connections at the UIP.

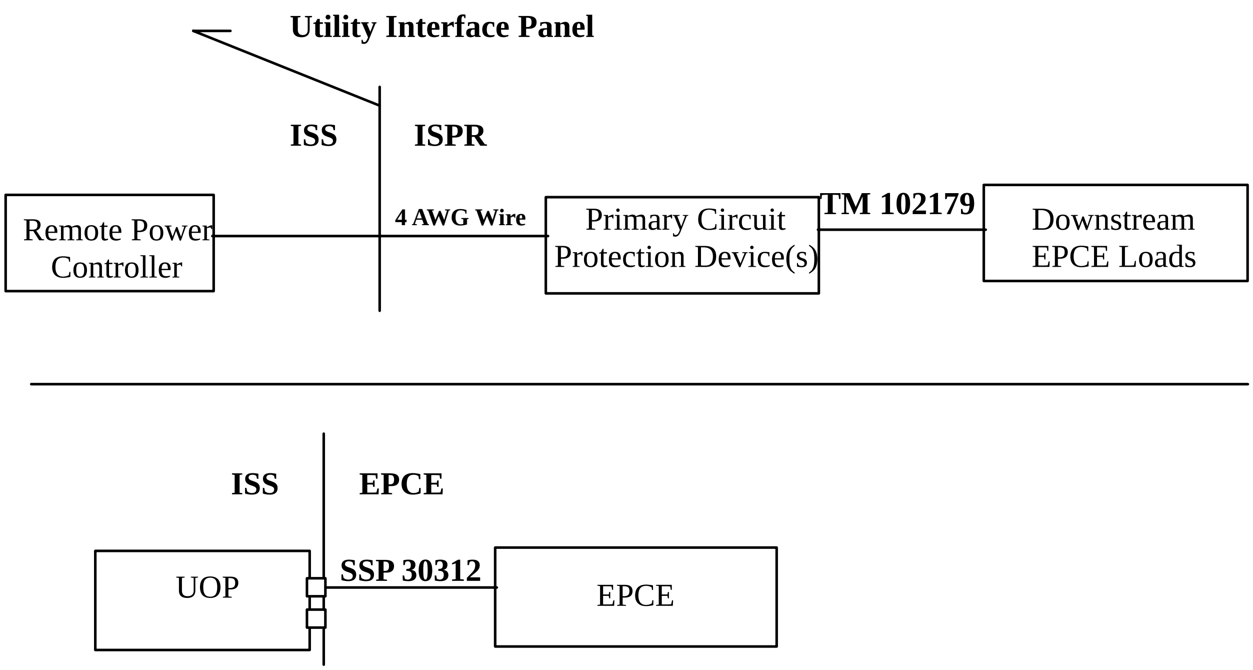


FIGURE 3.2.3.1–1 WIRE DERATING REQUIREMENTS FOR ISPR AND EPCE

3.2.3.2 EXCLUSIVE POWER FEEDS

A. An integrated rack shall receive power only from the UIP dedicated to its rack location.

B. Cabling shall not occur between Interface C connected EPCE with Interface B; and/or Interface B connected EPCE with Interface C.

3.2.3.3 LOSS OF POWER

Payloads shall fail safe in the event of a total or partial loss of power regardless of the availability of Auxiliary power in accordance with NSTS 1700.7, ISS Addendum.

3.2.4 ELECTROMAGNETIC COMPATIBILITY

The Integrated rack connected to Interface B and the EPCE connected to Interface C shall meet the EMC requirements of SSP 30243, paragraphs 3.1 and 3.6.2.

3.2.4.1 ELECTRICAL GROUNDING

The EPCE connected to either Interface B or Interface C shall meet all requirements specified in section 3 of SSP 30240.

3.2.4.2 ELECTRICAL BONDING

The integrated rack shall interface with the module bond strap per SSP 57001 Hardware ICD Template. Electrical bonding of EPCE connected to either Interface B or Interface C shall be in accordance with SSP 30245 and NSTS 1700.7, ISS Addendum sections 213 and 220.

3.2.4.3 CABLE/WIRE DESIGN AND CONTROL REQUIREMENTS

Cabling between payload EPCE and Interface B or Interface C shall meet all Cable and Wire Design requirements of SSP 30242.

3.2.4.4 ELECTROMAGNETIC INTERFERENCE

Payload EPCE shall meet all EMI requirements of SSP 30237.

Alternately, the payload EPCE may choose to accept a minimal increase of EMI risk with a somewhat less stringent Electric Field Radiated Susceptibility (RS03) requirement on equipment considered to be non-safety critical to the vehicle and crew. The tailored RS03 requirement, shown below, will hereafter be denoted RS03PL.

FREQUENCY	RS03PL LIMIT (V/m)
14 kHz – 400 MHz	5
400 MHz – 450 MHz	30
450 MHz – 1 GHz	5
1 GHz – 5 GHz	25
5 GHz – 6 GHz	60
6 GHz – 10 GHz	20
13.7 GHz – 15.2 GHz	25

COMMENTS:

1. The less stringent RS03PL limit was developed to envelope the electric fields generated by ISS transmitters and ground-based radars tasked to perform space surveillance and tracking. Ground-based radars that are not tasked to track the ISS and search radars that could momentarily sweep over the ISS are not enveloped by the relaxed RS03PL. For most scientific payloads, the minimal increase of EMI risk for the reduced limits is acceptable.

The RS03PL limit does not account for module electric field shielding effectiveness that could theoretically reduce the limits even more. Although shielding effectiveness exists, it is highly dependent on the EPCE location within the module with respect to ISS windows.

2. The conducted susceptibility requirements CS01, CS02 and CS06 are also used as the local stability requirements in paragraph 3.2.2.10.

3.2.4.5 ELECTROSTATIC DISCHARGE

Unpowered EPCE and components shall not be damaged by Electrostatic Discharge (ESD) equal to or less than 4,000 V to the case or any pin on external connectors. EPCE that may be damaged by ESD between 4,000 and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position. Labeling of EPCE susceptible to ESD up to 15,000 V shall be in accordance with MIL–STD–1686. These voltages are the result of charges that may be accumulated and discharged from ground personnel or crewmembers during equipment installation or removal.

3.2.4.6 ALTERNATING CURRENT (AC) MAGNETIC FIELDS

Payloads containing devices that intentionally generate magnetic fields (electromagnets) shall not generate AC magnetic fields that exceed the levels in the table below. This requirement applies at a distance of 7 centimeters (cm) from a point on the enclosure of the rack or equipment case nearest the source of the field.

Frequency	Magnitude (dBpT)
30 Hz	140
30 Hz to 3.5 kHz	Falling 26.5 dB/decade from 140 to 85
3.5 kHz to 50 kHz	85

Note: Requirements are not applicable to solenoid valves, solenoid relays, and electric motors with current of less than 1 Amp.

3.2.4.7 DIRECT CURRENT (DC) MAGNETIC FIELDS

Payloads containing devices that intentionally generate magnetic fields (electromagnets and permanent magnets) shall not generate DC magnetic fields that exceed 170 dB above a picotesla (dBpT). The requirement applies at a distance of 7 centimeters (cm) from a point on the enclosure of the rack or equipment case nearest to source of the field.

Note: Requirements are not applicable to solenoid valves, solenoid relays, and electric motors with power consumption of less than 120 Watts.

3.2.4.8 CORONA

Electrical and electronic subsystems, equipment, and systems shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is found in MSFC–STD–531, High Voltage Design Criteria.

3.2.4.9 LIGHTNING

The integrated rack and EPCE shall meet the lightning induced environment requirement in paragraph 3.2.8.1 of SSP 30243.

3.2.4.10 EMI SUSCEPTIBILITY FOR SAFETY-CRITICAL CIRCUITS

Payload safety-critical circuits, as defined in SSP 30243, shall meet the margins defined in SSP 30243, paragraph 3.2.3.

3.2.5 SAFETY REQUIREMENTS

3.2.5.1 PAYLOAD ELECTRICAL SAFETY

3.2.5.1.1 MATING/DEMATING OF POWERED CONNECTORS

EPCE shall meet the electrical safety requirements as defined in NSTS 1700.7 Addendum. Payloads shall comply with the requirements for mating/demating of powered connectors specified in NSTS 18798, MA2–99–170.

Note: The module can provide one verifiable upstream inhibit which removes voltage from the UIP and UOP connectors. The module design will provide the verification of the inhibit status at the time the inhibit is inserted.

3.2.5.1.2 SAFETY-CRITICAL CIRCUITS REDUNDANCY

EPCE shall meet the electrical safety requirements as defined in NSTS 1700.7 Addendum. The EPCE connected to either Interface B or Interface C shall meet the safety-critical circuits redundancy requirements defined in NSTS 18798.

3.2.5.2 RACK MAINTENANCE SWITCH (RACK POWER SWITCH)

A. Each integrated rack shall provide a guarded, two-position, manually operated lever lock switch that initiates the removal of power to the integrated rack, installed in a visible and accessible location on the front of the rack.

B. The Integrated Rack shall be wired such that the switch in the UP position provides a CLOSED circuit on the J43 connector pins 19 and 20.

C. Each Integrated Rack shall be labeled with JSC 27260 decal SDG32106318 with dash number as specified in Table 3.2.5.2–1.

Note: The MPLM does not have J43 connectors on rack locations to allow RMS implementation.

TABLE 3.2.5.2–1 RACK MAINTENANCE SWITCH (RACK POWER SWITCH) LABEL

USL Pre–8A	USL / CAM Post – 8A	JEM / APM
–001	–002	–003

3.2.5.3 POWER SWITCHES/CONTROLS

The following power switches/controls requirements apply to power to power interfaces with open circuit voltage exceeding 30 volts rms or dc nominal (32 volts rms or dc maximum).

A. Switches/controls performing on/off power functions for all power interfaces shall open (dead-face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power-off position.

B. Power-off markings and/or indications shall be used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit.

C. Standby, charging, or other descriptive nomenclature shall be used to indicate that the supply circuit is not completely disconnected for this power condition.

3.2.5.4 DELETED

3.2.5.5 PORTABLE EQUIPMENT/POWER CORDS

A. Non-battery powered portable equipment shall incorporate a three-wire power cord. A three–wire power cord consists of a (+) supply lead, a (–) return lead and a safety (green) wire; one end of the safety (green) wire is connected to the portable equipment chassis (and all exposed conductive surfaces) and the other end is connected to structure of the utility outlet (Payload provided outlet, UOP, etc.). A system of double insulation or its equivalent, when approved by NASA, may be used without a ground wire.

B. Non–battery power portable equipment shall provide a redundant ground path terminated at the connector back shell for output voltages exceeding 30 volts rms or dc nominal (32 volts rms or dc maximum). The redundant ground may be a fourth wire or the cable shield, provided that the shield is sized to carry the fault load.

Note: Non–battery powered portable equipment shall provide 1 Mohm dc isolation between power input to chassis and return to chassis invoked by paragraph 3.2.1.2 of the SSP 30240 as defined in SSP 57000, paragraph 3.2.4.1.

3.2.6 MPLM

An integrated rack (including Refrigerator/Freezer Rack) may require power while located in the MPLM. MPLM provides power to high power locations which are able to sustain a maximum steady-state current of 9.8 A and low power locations which are able to sustain a maximum steady-state current of 5.3 A. An integrated rack receiving power from the MPLM electrical power system must meet all requirements in sections 3.2.6.1 through 3.2.6.5. An integrated rack designed to operate in both the MPLM and any ISPR location must meet all requirements in sections 3.2.6.1 through 3.2.6.5 and all Interface B requirements in section 3.2.

3.2.6.1 MPLM ELECTRICAL POWER CHARACTERISTICS

The interface between an integrated rack (Refrigerator/Freezer Rack) and the MPLM electrical power system is shown in Figure 3.2.1–1, Electrical Power System Interface Locations. The integrated rack shall operate and be compatible with the Interface C electrical power characteristics in the following paragraphs:

A. Paragraph 3.2.1.1.2

B. Paragraph 3.2.1.2.1

C. Paragraph 3.2.1.2.2

D. Paragraph 3.2.1.3.2

E. Paragraph 3.2.1.3.3

F. Paragraph 3.2.1.3.4, A

G. Paragraph 3.2.1.3.4, B

3.2.6.2 MPLM ELECTRICAL POWER INTERFACE

Integrated rack shall meet the Interface C electrical power interface requirements in the following paragraphs:

A. Paragraph 3.2.2.6.1.1, B

B. Paragraph 3.2.2.6.1.1, D

C. Paragraph 3.2.2.7.2

D. Paragraph 3.2.2.8

E. Paragraph 3.2.2.9

F. Paragraph 3.2.2.10

3.2.6.2.1 MPLM UIP CONNECTORS AND PIN ASSIGNMENTS

A. Integrated rack connectors P1 mating requirements to the UIP connectors J1 are specified in paragraph 3.1.1.6.1, A.

B. Integrated rack connectors P1 shall meet the pin out interfaces of the UIP connectors J1 as specified in SSP 57001, paragraph 3.2.1.1.

C. Integrated rack connectors P1 shall meet the requirements of SSQ 21635 or equivalent.

3.2.6.2.2 COMPATIBILITY WITH RPC SOFT START/STOP IN MPLM

An integrated rack connected to Interface C in MPLM shall be compatible with the MPLM RPC soft start/stop performance characteristics defined in Figure 3.2.6.2.2–1 when power is applied, sustained, and removed by control of remote power control switches.

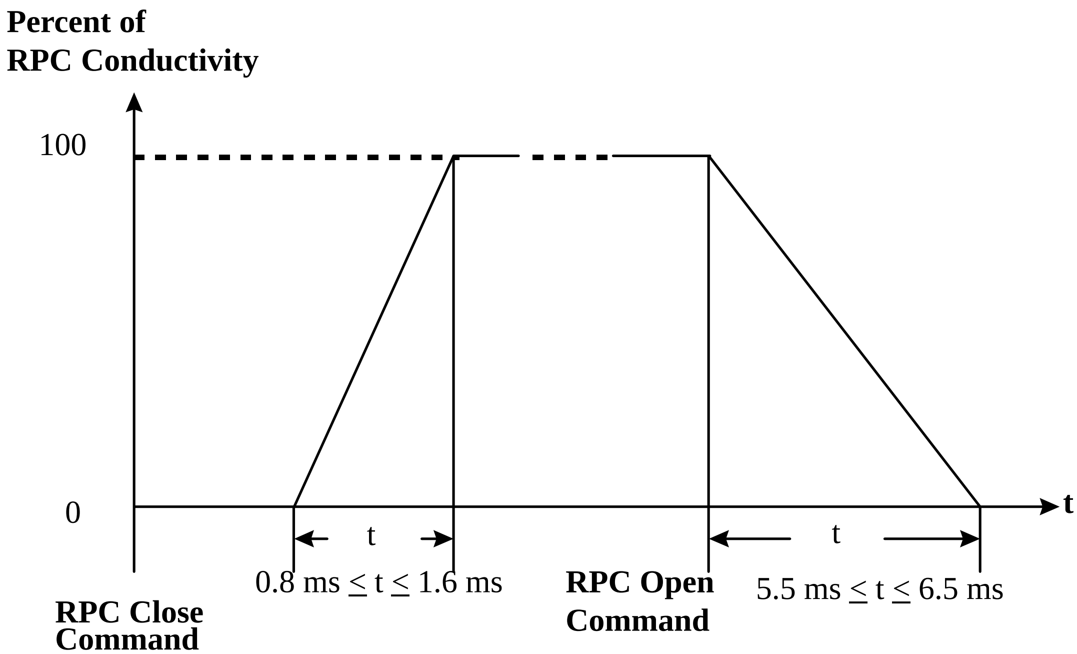


FIGURE 3.2.6.2.2–1 MPLM RPC SOFT START/STOP CHARACTERISTICS

3.2.6.2.3 MPLM SURGE CURRENT

When an integrated rack is powered from a voltage source with Interface C characteristics specified in paragraphs 3.2.1, with the exception that the source impedance is considered to be 0.1 ohm, the surge current requirements for all operating modes and changes including power-up and power-down are defined as follows:

A. The surge current for an integrated rack at the high power location shall not exceed 9.8 A.

B. The surge current for an integrated rack at the low power location shall not exceed 5.3 A.

C. The maximum current rate of change shall not exceed the values defined in Figure 3.2.2.4–2.

D. The duration of the surge current shall not exceed 9 milliseconds.

3.2.6.2.4 MPLM REVERSE ENERGY/CURRENT

The maximum reverse current from the integrated rack to MPLM EPS shall not exceed 0.9 Amps for the MPLM environmental conditions specified in Table 3.9.4–1 when powered from a voltage source with characteristics specified in paragraphs 3.2.6.1 with a source impedance of 0.1 ohm.

3.2.6.2.5 MPLM PAYLOAD TRIP RATINGS

The payload power circuit protection device in the integrated rack connected to either the high power location, or the low power location in MPLM, shall be designed to provide trip coordination, i.e., the downstream circuit protection device disconnects a shorter circuit or an overloaded circuit from the upstream power interface without tripping the upstream circuit protection device. The trip coordination is achieved either by shorter trip time or lower current limitation than the upstream protection devices defined in paragraph 3.2.2.6.1.1.B.

3.2.6.3 MPLM ELECTRICAL POWER CONSUMER CONSTRAINTS

Integrated rack shall meet the electrical power consumer constraints in the following paragraphs:

A. Paragraph 3.2.3.1.B

B. Paragraph 3.2.3.1.C

C. Paragraph 3.2.3.2.A

D. Paragraph 3.2.3.3

3.2.6.4 MPLM ELECTROMAGNETIC COMPATIBILITY

Integrated rack shall meet the electromagnetic compatibility requirements in the following paragraphs:

A. Paragraph 3.2.4.1, Electrical Grounding

B. Paragraph 3.2.4.2, Electrical Bonding

C. Paragraph 3.2.4.3, Cable/Wire Design and Control Requirements

D. Paragraph 3.2.4.4, Electromagnetic Interference

E. Paragraph 3.2.4.5, Electrostatic Discharge

F. Paragraph 3.2.4.6, Alternating Current (ac) Magnetic Fields

G. Paragraph 3.2.4.7, Direct Current (dc) Magnetic Fields

H. Paragraph 3.2.4.8, Corona

I. Paragraph 3.2.4.9, Lightning

J. Paragraph 3.2.4.10, EMI Susceptibility for Safety-Critical Circuits

3.2.6.4.1 MPLM BONDING

Integrated rack shall incorporate structural/mechanical provisions class R bonding to the MPLM in accordance with SSP 30245, Space Station Electrical Bonding Requirements.

3.2.6.5 MPLM SAFETY REQUIREMENTS

The integrated rack shall meet the safety requirements in the following paragraphs:

A. Paragraph 3.2.5.1.1

B. Paragraph 3.2.5.1.2

C. Paragraph 3.2.5.2

D. Paragraph 3.2.5.3

E. Paragraph 3.2.5.4

F. Paragraph 3.2.5.5

3.3 COMMAND AND DATA HANDLING INTERFACE REQUIREMENTS

3.3.1 DELETE

3.3.2 WORD/BYTE NOTATIONS, TYPES AND DATA TRANSMISSIONS

This section applies to all payload commands and data on the Low Rate Data Link (LRDL), all header/trailer data on the Medium Rate Data Link (MRDL) and High Rate Data Link (HRDL) stated in section 3.3 of this document.

3.3.2.1 WORD/BYTE NOTATIONS

The integrated racks shall use the word/byte notations as specified in paragraph 3.1.1, Notations in SSP 52050.

3.3.2.2 DATA TYPES

The integrated racks shall use the data types as specified in paragraph 3.2.1 and subsections, Data Formats in SSP 52050.

3.3.2.3 DATA TRANSMISSIONS

A. The integrated rack data transmission on Low Rate Data Link (LRDL), MIL–STD–1553B shall use the data transmission order in accordance with paragraph 3.4, Non-Signal Data Coding Standards in D684–10056–01, Prime Contractor Software Standards and Procedures Specification.

B. The integrated rack data transmission on Medium Rate Data Link (MRDL) shall use the data transmission order in accordance with paragraph 3.3.3.1, Transmission Order in SSP 52050.

C. The integrated rack data transmission on High Rate Data Link (HRDL) shall use the data transmission order in accordance with paragraph 1.6, Bit Numbering Convention and Nomenclature in CCSDS 701.0–B–2.

3.3.3 DELETED

3.3.4 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS

Integrated racks will use the Consultative Committee for Space Data Systems (CCSDS) standards for Space to Ground and Ground to Space data and time requirements as specified in this section.

3.3.4.1 CCSDS DATA

A. Integrated rack data that is space to ground shall be either CCSDS Data Packets or CCSDS Bitstream.

B. Integrated rack data that is ground to space shall be CCSDS Data Packets.

C. Integrated rack to Payload MDM data shall be CCSDS Data Packets.

3.3.4.1.1 CCSDS DATA PACKETS

Integrated rack data packets shall be developed in accordance with paragraph 3.1.3 of SSP 52050. Integrated racks CCSDS data packets consist of a primary header and a secondary header followed by the data field.

3.3.4.1.1.1 CCSDS PRIMARY HEADER

Integrated racks shall develop a CCSDS primary header in accordance with paragraph 3.1.3.1 CCSDS Primary Header Format of SSP 52050.

3.3.4.1.1.2 CCSDS SECONDARY HEADER

A. Integrated racks shall develop a CCSDS secondary header immediately following the CCSDS primary header.

B. The CCSDS secondary header shall be developed in accordance with paragraph 3.1.3.2, CCSDS Secondary Header Format of SSP 52050.

3.3.4.1.2 CCSDS DATA FIELD

The integrated rack CCSDS data field shall contain the integrated rack data from the transmitting application to the receiving application, and the CCSDS checksum in accordance with paragraph 3.1 and subparagraphs, Data Formats and Standards, of SSP 52050.

3.3.4.1.3 CCSDS DATA BITSTREAM

Integrated rack bitstream data shall be developed in accordance with paragraph 2.3.2.3, Bitstream Service of CCSDS 701.0–B–2.

3.3.4.1.4 CCSDS APPLICATION PROCESS IDENTIFICATION FIELD

The CCSDS Application Process Identification (APID) will be used for routing data packets as described in paragraph 3.3.2.1.3, APID routing, of SSP 41175–2. The format of APIDs is shown in Table 3.3.2.1.1–1, CCSDS Primary Header Field Definitions, of SSP 41175–2.

Telemetry APIDs for a payload or subrack payload will be assigned by the Payload Engineering and Integration function upon request from the payload or subrack payload developer or rack integrator, and will be recorded in the integrated rack unique software ICD.

3.3.4.2 CCSDS TIME CODES

3.3.4.2.1 CCSDS UNSEGMENTED TIME

Integrated racks shall use CCSDS unsegmented time code (CUC) in the secondary header as specified in paragraph 2.2, CCSDS Unsegmented Time Code (CUC), of CCSDS 301.0–B–2.

3.3.4.2.2 CCSDS SEGMENTED TIME

Segmented time code will be sent to the integrated rack by a broadcast message on the Payload MIL–STD–1553B. Segmented time code formats is specified in paragraph 2.4, CCSDS Calendar Segmented Time Code (CCS), of CCSDS 301.0–B–2.

The broadcast time will be received at subaddress #29 on each Payload MIL–STD–1553B bus. The broadcast time signal will be updated once a second and is accurate to ±2.5 ms with respect to the Space Station Global Positioning System (GPS) receiver.

3.3.5 MIL-STD-1553B LOW RATE DATA LINK (LRDL)

Each integrated rack shall implement a single MIL–STD–1553B Remote Terminal (RT) to the payload unique MIL–STD–1553B bus in accordance with paragraph 3.2, MIL–STD–1553B Interface, of SSP 52050.

3.3.5.1 MIL-STD-1553B PROTOCOL

3.3.5.1.1 STANDARD MESSAGES

Integrated racks shall develop standard message for the Payload MIL–STD–1553B in accordance with paragraph 3.2.3.3, Standard Messages of SSP 52050.

3.3.5.1.2 COMMANDING

Integrated racks shall receive and process commands from the Payload MDM that originate from the Ground, Timeliner, Payload MDM and Portable Computer System (PCS) in accordance with paragraph 3.2.3.4, Commanding of SSP 52050.

3.3.5.1.3 HEALTH AND STATUS DATA

A. Integrated racks shall develop health and status data in accordance with paragraph 3.2.3.5, Health and Status of SSP 52050. The health and status data shall be documented in accordance with the data field format defined in Table A–5, Health and Status ISS Processed Data Packets, of SSP 57002. The definition of health and status data is provided in the Glossary of Terms, Appendix B of this document.

B. Integrated racks shall respond to their respective payload MDM polls for health and status data with updated data at a 1 Hz or 0.1 Hz rate.

C. Payloads interfacing with the MPLM shall set the Busy Bit to logic “1” in the event its H&S data packet is not available for transfer to the MPLM MDM.

D. Payloads interfacing with the MPLM shall zero fill the unused words in the H&S data packets when the size of the H&S data packet is less than a multiple of 32 words.

E. Payloads interfacing with the MPLM shall update H&S data a time such that the Frame Count (received in Broadcast sync with Data) modulo 10 equals any one of the following values: 2, 3, 4, 7, 8, or 9.

Note: The MPLM will collect 96 words of H&S data from the Minus Eighty Degree Laboratory Freezer for the ISS (MELFI), and will collect 32 words of data from the +4/–26 Degree Refrigerator Freezer and from the Laboratory Support Equipment Transportation Rack Freezer.

3.3.5.1.4 SAFETY DATA

A. Safety data is the set of payload generated C&W related parameters that are required to be available in the CCS MDM for S–band downlink, display to the crew on a core PCS, or monitored for C&W events. Determination of the safety–related parameters that are required is the responsibility of the PD/PI. An example of safety–related data is a current or temperature sensor parameter which is being monitored for a situation that could lead to fire or overheating. Safety data shall be included in the H&S data CCSDS packets provided by ISPR RTs.

B. Integrated racks shall provide as safety data the standard rack caution and warning status words in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050.

3.3.5.1.4.1 CAUTION AND WARNING

For the purpose of Caution and Warning (C&W) classifications, the sensors are the integrated racks means of detecting events that were deemed necessary by the PSRP during the Phased Safety Reviews. The sensors used to produce Caution and Warning Events are determined by the payload developer, advisories may be set if the payload developer identifies a situation that meets the classification of an advisory.

3.3.5.1.4.1.1 CLASS 1 – EMERGENCY

All of the defined ISS Emergency conditions are reported by the ISS systems or the rack smoke detector, integrated racks and equipment will not report an Emergency condition.

(1) The emergency condition rapid cabin depressurization will be detected by the ISS module sensors.

(2) The emergency condition of toxic atmosphere is set as a scar.

(3) Payload Fire emergency's can only be declared as a confirmed fire event by the ISS rack smoke detector or equivalent, which can detect 96% of the smoke detector failures.

When an emergency event is detected, the format of the data will identify the event type (fire, toxic atmosphere, depressurization)

Emergency conditions require all onboard crew to respond immediately.

3.3.5.1.4.1.2 CLASS 2 – WARNING

Integrated racks shall format the caution and warning word in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as a warning when the integrated rack sensors detect the following conditions:

(1) A potential fire event, (detected by a sensor other than an ISS rack smoke detector or equivalent)

(2) A precursor event that could manifest to an emergency condition (toxic atmosphere, rapid cabin depressurization or fire) and

(a) automatic safing has failed to safe the event or

(b) the system is not automatically safed (i.e. requires manual intervention)

(3) An event that results in the loss of a hazard control and

(a) automatic safing has failed to safe the event or

(b) the system is not automatically safed (i.e. requires manual intervention)

Note: A Warning requires someone to take action immediately. Warnings are used for events that require manual intervention and for notification when automatic safing fails.

3.3.5.1.4.1.3 CLASS 3 – CAUTION

Integrated racks shall format the caution and warning word in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as a caution when the integrated rack sensors detect the following conditions:

(1) A precursor event that could manifest to an emergency condition (toxic atmosphere, rapid cabin depressurization or fire) and automatic safing has safed the event (i.e. the system does not require manual intervention)

(2) An event that results in the loss of a hazard control and automatic safing has safed the event (i.e., the system does not require manual intervention)

Note: A Caution requires no immediate action by the crew. Automatic safing has controlled the event.

3.3.5.1.4.1.4 CLASS 4 – ADVISORY

Integrated racks that require an advisory shall format the caution and warning word in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as an advisory. Advisories are set for the following conditions:

(1) Advisories are set primarily for ground monitoring purposes (advantageous due to limited comm. coverage and data recording).

(2) Data item that most likely will not exist permanently in Telemetry List but should be time tagged and logged for failure isolation, trending, sustaining engineering, etc.

3.3.5.1.5 SERVICE REQUESTS

Integrated racks shall develop service requests shall be in accordance with paragraph 3.2.3.7, Service Requests of SSP 52050. The service requests data format, shall be developed in accordance with Table 3.2.3.7–1, Service Requests, of SSP 52050.

3.3.5.1.6 ANCILLARY DATA

Information regarding ancillary data that can be made available to payloads is contained in paragraph 3.2.3.8, Ancillary Data, of SSP 52050.

3.3.5.1.7 FILE TRANSFER

Integrated racks requiring file transfer shall develop its file transfer in accordance with paragraph 3.2.3.9, File Transfer, of SSP 52050.

3.3.5.1.8 LOW RATE TELEMETRY

Integrated racks requiring low rate telemetry shall develop low rate telemetry (i.e. science data) in accordance with paragraph 3.2.3.10, Low Rate Telemetry of SSP 52050.

3.3.5.1.9 DEFINED MODE CODES

Integrated racks MIL–STD–1553B mode codes are defined in paragraph 3.2.3.2.1.5, Data Word Count/Mode Code in SSP 52050. The MPLM does not support the Initiate Self–Test or Transmit BIT Word mode codes referenced in that paragraph and listed in Table 3.2.3.2.1.5–1 of SSP 52050.

3.3.5.1.10 IMPLEMENTED MODE CODES

Integrated racks shall implement MIL–STD–1553B mode codes in accordance with paragraph 3.2.3.2.1.5, Data Word Count/Mode Code, and Table 3.2.3.2.1.5–1, Mode Codes of SSP 52050.

3.3.5.1.11 UNIMPLEMENTED/UNDEFINED MODE CODES

The integrated rack MIL–STD–1553B Remote Terminal (RT) may be designed to recognize both unimplemented and undefined mode codes as illegal commands. If the RT designer does decide to monitor for unimplemented/undefined code modes, the RT shall respond by setting the message error bit in the status word.

3.3.5.1.12 ILLEGAL COMMANDS

The integrated rack MIL–STD–1553B RTs are not required to respond to illegal commands. If a RT designed with this option detects an illegal command, it shall respond to the illegal command by setting the message error bit in the status word.

3.3.5.2 MIL-STD-1553B LOW RATE DATA LINK (LRDL) INTERFACE CHARACTERISTICS

3.3.5.2.1 LRDL REMOTE TERMINAL ASSIGNMENT

3.3.5.2.1.1 LRDL CONNECTOR/PIN ASSIGNMENTS

3.3.5.2.1.2 MIL–STD–1553B BUS A AND B CONNECTOR/PIN ASSIGNMENT

A. Integrated rack connectors P3 and P4 mating requirements to the UIP connector J3 and J4 are specified in Table 3.1.1.6.1–1, Module Connectors, items C and D.

B. Integrated rack connectors P3 and P4 shall meet the pin out interfaces of the UIP J3 and J4 connectors respectively as specified in paragraph 3.3.2.2, Connectors, of SSP 57001.

C. Integrated rack connectors P3 and P4 shall meet the requirements of SSQ 21635 or equivalent.

3.3.5.2.1.3 DELETED

3.3.5.2.1.4 REMOTE TERMINAL HARDWIRED ADDRESS CODING

A. The integrated rack shall be designed to read and respond to the hardware remote terminal address coding scheme for the Standard Payload Bus, for all ISPR locations defined in Table 3.3.5.2.1.4–1. Details of the implementation of the payload remote terminals are illustrated in Figure 3.3.5.2.1.4–1.

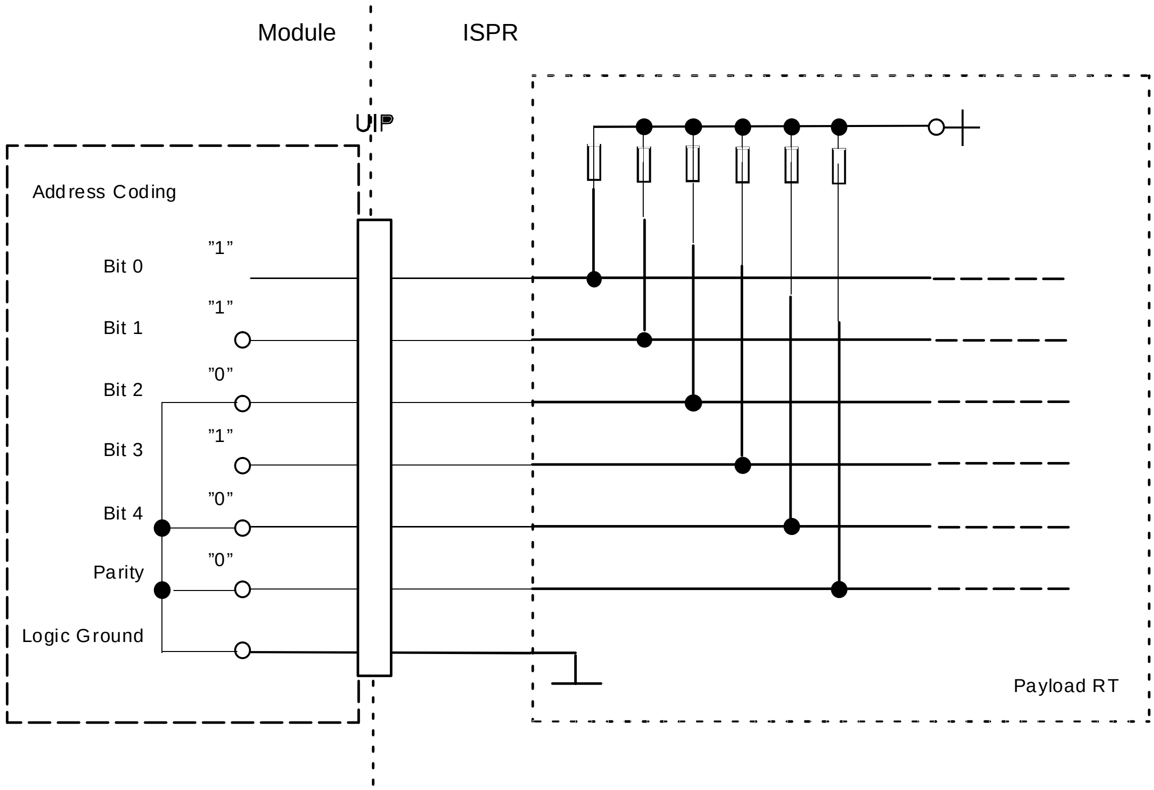
B. Decimal values shall be mapped in 5 bit representation, bit 0 = Least Significant Bit (LSB), see Figure 3.3.5.2.1.4–1.

C. Odd–parity shall be used.

D. Jumpering address line to ground shall be logic 0.

TABLE 3.3.5.2.1.4–1 REMOTE TERMINAL HARDWIRED ADDRESS CODING FOR STANDARD PAYLOAD BUS

APM ISPR			JEM ISPR			USL ISPR			CAM ISPR		
Location	Payload Bus	RT Hard-wired Address	Location	Payload Bus	RT Hard-wired Address	Location	Payload Bus	RT Hard-wired Address	Location	Payload Bus	RT Hard-wired Address
APM1F1	LB PL–APM	15	JPM1F1	LB PL–JEM	15	LAB1O1	LB PL–2	8	CAM1F3	LB PL–3	20
APM1F2	LB PL–APM	16	JPM1F2	LB PL–JEM	16	LAB1O2	LB PL–3	9	CAM1F5	LB PL–3	21
APM1F3	LB PL–APM	17	JPM1F3	LB PL–JEM	17	LAB1O3	LB PL–3	10	CAM1A3	LB PL–4	24
APM1F4	LB PL–APM	18	JPM1F5	LB PL–JEM	18	LAB1O4	LB PL–3	11	CAM1A4	LB PL–4	21
APM1A1	LB PL–APM	19	JPM1F6	LB PL–JEM	19	LAB1O5	LB PL–3	12	CAM1A5	LB PL–4	20
APM1A2	LB PL–APM	20	JPM1A1	LB PL–JEM	20	LAB1S1	LB PL–4	8			
APM1A3	LB PL–APM	21	JPM1A2	LB PL–JEM	21	LAB1S2	LB PL–4	9			
APM1A4	LB PL–APM	22	JPM1A3	LB PL–JEM	22	LAB1S3	LB PL–4	10			
APM1O1	LB PL–APM	23	JPM1A4	LB PL–JEM	23	LAB1S4	LB PL–4	11			
APM1O2	LB PL–APM	24	JPM1A5	LB PL–JEM	24	LAB1D3	LB PL–4	14			
						LAB1P1	LB PL–1	12			
						LAB1P2	LB PL–2	15			
						LAB1P4	LB PL–3	17			



Note: Example RT address = 11 in decimal representation.
All address and parity lines have pull u resistors so that "0" on those lines is achieved by connecting the lines to ISPR RT Logic Ground. The parity is odd. Bit 0 is LSB.

FIGURE 3.3.5.2.1.4–1 REMOTE TERMINAL HARDWIRED ADDRESS CODING (EXAMPLE)

3.3.5.2.2 LRDL SIGNAL CHARACTERISTICS

The integrated rack MIL–STD–1553B terminal characteristics shall be in accordance with section 4.5.2, Terminal Characteristics of MIL–STD–1553B, Notice 2.

3.3.5.2.3 LRDL CABLING

A. The integrated rack MIL–STD–1553B internal wiring characteristics shall be according to SSQ 21655, Cable, Electrical, MIL–STD–1553B Data Bus, Space Quality, General Specifications for 75 Ohm or equivalent.

B. The integrated rack MIL–STD–1553B internal wiring stub length shall not exceed 12 feet, (3.65 meters), when measured from the internal MIL–STD–1553B Remote Terminal to the ISPR Utility Interface Panel.

3.3.5.2.4 MULTI–BUS ISOLATION

For Payloads utilizing multiple ISS Payload MIL–STD–1553B data buses, the signal isolation between the buses shall be no less than 58 dB. A data bus consists of a redundant pair, channel A and channel B. It matters not that the data buses exit the payload on the same or different connectors, nor that the data buses are connected to the same or different buses. This requirement does not apply to payload unique buses.

3.3.6 MEDIUM RATE DATA LINK (MRDL)

3.3.6.1 MRDL PROTOCOL

Integrated racks that communicate via the MRDL shall conform with ISO/IEC 8802–3 10–Base-T protocol in accordance with paragraph 3.3, Medium Rate Data Link of SSP 52050.

3.3.6.1.1 INTEGRATED RACK PROTOCOLS ON THE MRDL

Integrated racks that communicate via the MRDL shall conform with ISO/IEC 8802–3 10–Base-T protocol in accordance with paragraph 3.3, Medium Rate Data Link (MRDL) of SSP 52050.

Payloads sending data to the ground through the USOS Space to Ground Link shall use the CCSDS protocol and gateway protocol in paragraph 3.3.4, Gateway Protocol and 3.3.3.7, Length in SSP 52050.

3.3.6.1.2 MRDL ADDRESS

A. Integrated racks implementing MRDL shall have a (unique) IEEE issued Ethernet Media Access Control (MAC) physical address (MAC Address), for each MRDL attachment.

B. Subrack payloads or non–rack payloads that are internal to the integrated rack which utilize the MRDL shall have a (unique) IEEE issued MAC Address(es).

C. The MAC address shall be set prior to the Ethernet terminal going active. The integrated rack will indicate the MAC address in the payload unique software ICD.

Note: Recommendation to the integrated rack developer is to hard code the MAC address.

3.3.6.1.3 ISPR MRDL CONNECTIVITY

ISPR MRDL connectivity information may be found in section 3.3, Medium Rate Data Link, of SSP 52050.

A. Each integrated rack with a MRDL connection shall have no more than one physical connection per LAN. An integrated rack with a MRDL connection may have one physical connection to LAN–1 and one physical connection to LAN–2. LAN–1 is located in J46 and LAN–2 is located in J47.

B. Integrated racks shall not route or transmit the same MRDL message to the ISS LANs simultaneously.

C. Integrated racks with internal MRDL(s) shall provide isolation between the ISS MRDL LANs and the internal LANs with either an Ethernet Bridge or an Internet Protocol router that connects the LAN–1 and LAN–2 to the internal rack LAN(s).

3.3.6.1.4 MRDL CONNECTOR/PIN ASSIGNMENTS

A. Integrated rack connectors P46 and P47 mating requirements to the UIP connectors J46 and J47 are specified in paragraph 3.1.1.6.1, I and J.

B. Integrated rack connectors P46 and P47 shall meet the pin out interfaces of the UIP J46 and J47 connectors as specified in SSP 57001, paragraph 3.3.3.1.

C. Integrated rack LAN–1 and LAN–2 connectors P46 and P47 shall meet the requirements of SSQ 21635 or equivalent.

3.3.6.1.5 MRDL SIGNAL CHARACTERISTICS

Payloads which require connectivity to the MRDL shall meet the electrical characteristics of MRDL in accordance with ISO/IEC 8802–3 with the following exceptions:

IEC Publication	60	High-Voltage Test Techniques
IEC Publication	380	Safety of Electrically Energized Office Machines
IEC Publication	435	Safety of Data Processing Equipment
IEC Publication	950	Safety of Information Technology Equipment, Including Electrical Business Equipment

3.3.6.1.6 MRDL CABLE CHARACTERISTICS

The cable characteristics are given in Table 3.3.6.1.6–1.

TABLE 3.3.6.1.6–1 LINK SEGMENT CABLE CHARACTERISTICS

Characteristic	Parameter
Characteristic Impedance	100 ±7 Ohm
Cable Size	22 AWG
Type of Cable	Twisted Shielded Pair SSQ 21655 or Equivalent
Nominal wire-to-wire Capacitance	45 pF/m
Max Cable Length in ISPR	5 m

3.3.7 HIGH RATE DATA LINK (HRDL) (TBR #15) (TBR#16)

3.3.7.1 PAYLOAD TO HIGH RATE FRAME MULTIPLEXER (HRFM) PROTOCOLS

HRDL stations that require the use of High Rate Frame Multiplexer (HRFM), through the USOS Ku–Band system, shall operate under the downlink protocols. Downlink protocols consist of two rigidly defined protocols: the Consultative Committee for Space Data Systems (CCSDS) Packet protocol and Bitstream protocol.

3.3.7.1.1 CCSDS PACKET PROTOCOL

Integrated racks implementing CCSDS packet protocol is defined in section 3.3.3.1, CCSDS Packet Protocol of SSP 50184.

3.3.7.1.1.1 PACKET DATA FRAMES

Integrated racks shall implement data frames in accordance with section 3.3.3.1.1, CCSDS Packet Data Frames and Figure 3.3–3, HRDL CCSDS Packet Format & Framing of SSP 50184.

3.3.7.1.1.2 PACKET DATA RATES

Integrated racks shall modulate the HRDL data rate by the insertion of Sync symbols in the data stream. The number and distribution of Sync symbols shall be in accordance with section 3.3.3.1.2, Packet Data Rates of SSP 50184.

3.3.7.1.1.3 PACKET FORMAT

Integrated racks shall implement data packets in accordance with section 3.3.3.1.3, CCSDS Packet Format and Figure 3.3–4 CCSDS Packet Format of SSP 50184.

3.3.7.1.2 BITSTREAM PROTOCOL

Bitstream protocol is defined in section 3.3.3.2, Bitstream Protocol of SPS 50184.

3.3.7.1.2.1 DATA FRAMES

Integrated racks shall transmit data on the HRDL network as bitstream data in accordance with section 3.3.3.2.1, Bitstream Data Frames and Figure 3.3–5, HRDL Bitstream Format of SSP 50184.

3.3.7.1.2.2 DATA RATES

Integrated racks shall modulate the HRDL data rate by the insertion of Sync symbols in the data stream. The number and distribution of Sync symbols shall be in accordance with section 3.3.3.2.2, Bitstream Data Rates of SSP 50184.

3.3.7.2 HRDL INTERFACE CHARACTERISTICS

3.3.7.2.1 PHYSICAL SIGNALING

Physical signaling of the HRDL will be in accordance with section 3.1, Physical Signaling of SSP 50184.

3.3.7.2.1.1 PHYSICAL SIGNALING DATE RATES

A. DELETED

B. The integrated rack shall assign its selectable data rate values between zero (0) and 95 Mbps. The ideal data rate value is 0.432 Mbps. The data rate will be adjustable in steps that minimize bandwidth waste through HRFM.

C. Transmitted data shall be designed to be in accordance with section 3.3.1.2, General Data Rates, section 3.3.3.1.2, Packet Data Rates, and section 3.3.3.2.2, Bitstream Data Rates of SSP 50184.

Note: The integrated rack's maximum designed data rate is subject to planning.

3.3.7.2.2 ENCODING

Integrated racks using the HRDL shall encode the data in accordance with section 3.1.3, Encoding of SSP 50184.

3.3.7.3 INTEGRATED RACK HRDL OPTICAL POWER

3.3.7.3.1 INTEGRATED RACK HRDL TRANSMITTED OPTICAL POWER

The integrated rack that transmits data on the HRDL, with or without an ARIS adapter, shall be designed to transmit a HRDL signal in accordance with section 3.1.1, Transmitter Optical Characteristics of SSP 50184 at an average optical power greater than –16.75 dBm and less than –8.3 dBm. The integrated rack transmitted optical power will be measured at the integrated rack P7 connector to the ISPR connector interface panel using the Halt symbol in accordance with Table 3.1–3, 4B/5B NRZI Encoding in SSP 50184.

3.3.7.3.2 INTEGRATED RACK HRDL RECEIVED OPTICAL POWER

The integrated rack that receives data on the HRDL, with or without an ARIS adapter, shall be designed to receive a HRDL signal in accordance with section 3.1.2, Receiver Optical Characteristics of SSP 50184 at an average optical power less than or equal to –30.45 dBm. The integrated rack received optical power will be measured at the integrated rack P7 connector to the ISPR connector interface panel using the Halt symbol in accordance with Table 3.1–3, 4B/5B NRZI Encoding in SSP 50184.

3.3.7.4 HRDL FIBER OPTIC CABLE

The integrated rack shall use fiber optic cable in accordance with SSQ 21654, or meet/exceed the performance of the SSQ cable.

3.3.7.5 HRDL FIBER OPTIC CABLE BEND RADIUS

The integrated rack shall develop the routing, installation and handling procedures to assure the minimum bend radius of 2 inches or greater is maintained at all times for the Fiber Optic Cable, as derived from SSQ 21654 section 3.10.5, except where protected by a connector backshell, where a one half inch radius is permitted for bends of 90–degrees or less.

3.3.7.6 HRDL CONNECTORS AND FIBER

A. Integrated rack connector P7 mating requirement to the UIP connector J7 is specified in section 3.1.1.6.1, E.

B. Integrated rack connector P7 shall meet the pin out interfaces of the UIP J7 connector as specified in SSP 57001, section 3.3.4.1.

C. Integrated rack HRDL connector P7 shall meet the requirements of SSQ 21635 or equivalent.

D. Integrated rack HRDL fiber shall meet the requirements of SSQ 21654 or equivalent.

3.3.7.7 DELETED

3.3.7.8 HRDL STATE

The HRDL state shall be in accordance with section 3.3.1.1, HRDL State Diagram of SSP 50184.

3.3.8 PERSONAL COMPUTERS

There are three types of personal computers available for payload operations: the Payload Laptop, Portable Computer System (PCS), and the Station Support Computer (SSC).

3.3.8.1 PAYLOAD LAPTOP

The Payload Laptop is a rack unique laptop which is provided by the Payload Developer (PD). The primary purpose of the Payload Laptop is to provide rack and experiment control and display. Requirements for the Payload Laptop are detailed below.

A. Payload racks which require a laptop shall utilize an IBM 760XD (model 9546U9E) laptop per JSC 27337, Project Technical Requirements Specification for the PCS.

B. Payload Laptops shall utilize a Windows NT 4.0 software load supporting the following standard services (Computer Browser, Internet Info Server 4.0, TCP/IP Printing, NetBIOS Interface, Network Monitor & Tools, RPC Config, Server, Transaction Server, Workstation) with TCP/IP Protocol suite.

C. Payload Laptop displays shall be in accordance with SSP 50313, Display and Graphical Commonality Standard.

D. Each rack shall be limited to one Payload Laptop computer.

E. The Payload Laptop shall interface to the rack via a front panel connection utilizing the connectors as specified in Table 3.3.8.1–1 and pin outs per SSP 57001, Figures 3.3.6–1 through 3.3.6–5.

F. Data / power cables shall be per design specified in drawings shown in Figure 3.3.8.1–1.

G. A 28V power converter, shown in Figure 3.3.8.1–1, shall be per design specified in drawing SED39126010–305.

H. The Payload Laptop shall be attached to the rack seat track via the multi–use bracket, SEG33107631–301 and PGSC desk, Shuttle P/N SED33108703–302 or equivalent.

TABLE 3.3.8.1–1 RACK CONNECTOR PART NUMBERS

Power	MS3474L14–12S
RS–232	MS27468T15F35SA
Ethernet	MS27468T11F35S
Video	BJ76

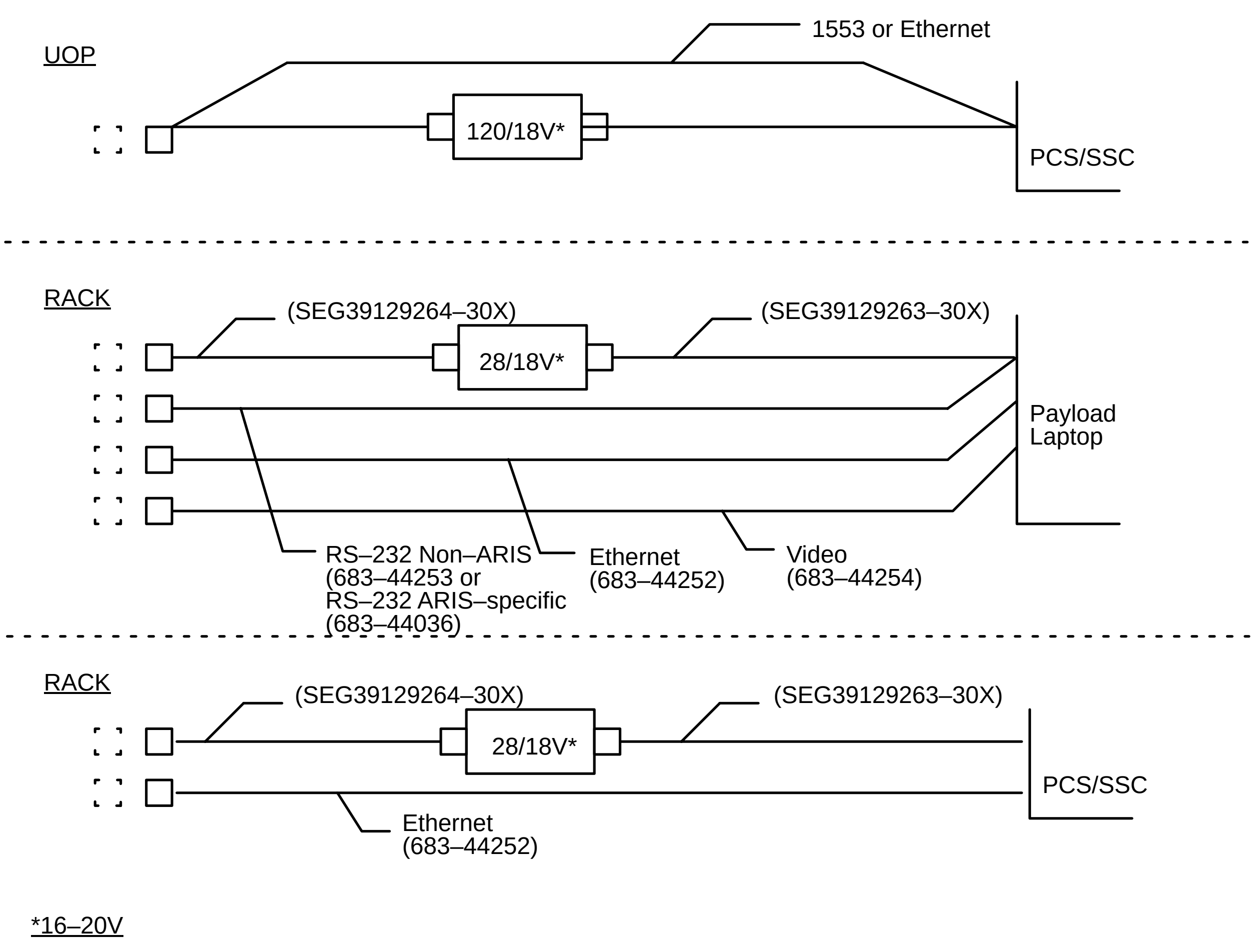


FIGURE 3.3.8.1–1 DATA/POWER CABLE DESIGN

3.3.8.2 PCS

The PCS is a complement level laptop which is a shared ISS resource. The purpose of the PCS is to provide 1553 connectivity to the C&C and Payload MDMs. PCS has the following displays available for use by the crew: vehicle displays, complement level payload displays, and if requested, payload unique displays. All of these run under the Solaris operating system. The IBM 760XD laptop hardware also provides Ethernet, RS–232 and RS–422 interfaces. The PCS is only connected to the payload 1553 bus for payload command and control. However, the PCS hardware and Solaris OS is available as a shared resource for direct connection to a payload rack. Ethernet, RS–422/232 user display and interface control software must be provided by the payload developers. All payload developed software for use on PCS must be delivered to the PSIV for integration into a payload complement load.

A. All payload software to be used on PCS shall adhere to the PCS Interface Definition Document (IDD), SSP 52052.

B. PCS displays shall be in accordance with SSP 50313, Display and Graphical Commonanilty Standard. (not unique to PCS)

C. Each integrated rack shall be limited to one shared PCS. The PCS is not dedicated to a rack; memory and hard drive availability for payload displays and software must be negotiated with the Payload Software Control Panel.

3.3.8.2.1 PCS TO UOP INTERFACE

A. The PCS interface to payloads is through the MIL–STD–1553B (PLMDM) port or SSMB (Ethernet) port of a UOP in accordance with paragraph 3.2.1.2 of SSP 57001.

B. A 120V power converter and data / power cables are utilized as shown in Figure 3.3.8.1–1.

3.3.8.2.2 760XD LAPTOP TO RACK INTERFACE

A. The integrated rack shall interface with the 760XD via a front panel connection utilizing the connectors as specified in Table 3.3.8.1–1 and pin outs per SSP 57001, Figures 3.3.6–1 through 3.3.6–5.

B. Data / power cables shall be per design specified in drawings shown in Figure 3.3.8.1–1.

C. A 28V power converter, shown in Figure 3.3.8.1–1, shall be per design specified in drawing SED39126010–305.

D. The 760XD shall be attached to the rack seat track via the multi–use bracket, SEG33107631–301 and PGSC desk, Shuttle P/N SED33108703–302.

3.3.8.3 SSC

The SSC shares the same hardware platform as the PCS (IBM 760), and is provided as a shared ISS resource. The primary purpose of the SSC is to provide crew support applications, including the Manual Procedures & Onboard Short Term Plan viewers, the Inventory Management System Database, Worldmap and other such tools. The SSC communicates via Ethernet as part of the ISS Ops LAN (IOL), and does not interface with any 1553 MDM systems. The SSC utilizes a Windows 95 O/S and follows Microsoft Windows display standards for GUI generation. The SSC connects to the UOP's for power only. RS 232, 422, or Ethernet connections exist to support direct connectivity to payload hardware.

A. Each integrated rack shall be limited to one shared SSC. The SSC is not dedicated to a rack; memory and hard drive availability for payload displays and software must be negotiated with the Payload Software Control Panel.

B. SSC displays shall be in accordance with SSP 50313, Display and Graphic Commonality Standard. (not unique to SSC).

3.3.9 UOP

UOP mating, pinout, and SSQ requirements are located in section 3.2.2.1.

3.3.10 MAINTENANCE SWITCH, SMOKE DETECTOR, SMOKE INDICATOR, AND INTEGRATED RACK FAN INTERFACES

3.3.10.1 RACK MAINTENANCE SWITCH (RACK POWER SWITCH) INTERFACES

The integrated rack power off command interface characteristics shall be in accordance with Table 3.3.10.1–1, Bi-Level Data Characteristics (Switch Contact).

TABLE 3.3.10.1–1 BI-LEVEL DATA CHARACTERISTICS (SWITCH CONTACT)

PARAMETER	ENG. UNIT	ISPR
Type Transfer		Floating (Isolation resistance >1MΩ) dc coupled
I/F Resistance (closed)	Ω	< 2.5
I/F Resistance (open)	MΩ	> 1
Open Circuit Leakage Current	μA	0 to 100
Operating Current (closed)	mA	0.2 to 30
Minimum Open Circuit Voltage	V	20

3.3.10.2 SMOKE DETECTOR INTERFACES

The smoke detector interface consists of :

1 analog obscuration signal from integrated rack to the module

1 analog scatter signal from integrated rack ISPR to the module

1 discrete built in test command from module to integrated rack.

The analog data monitoring interface characteristics will be as described in paragraph 3.3.10.2.1, Analog Interface Characteristics.

The discrete built in test command interface characteristics will be as described in paragraph 3.3.10.2.2 Discrete Command Interface Characteristics.

The electrical power is supplied to the smoke detector from the rack internal power distribution.

3.3.10.2.1 ANALOG INTERFACE CHARACTERISTICS

The electrical characteristics (signal source) of the active driver interface shall be in accordance with Table 3.3.10.2.1–1, Electrical Characteristics Envelope of Analog Signals.

TABLE 3.3.10.2.1–1 ELECTRICAL CHARACTERISTICS ENVELOPE OF ANALOG SIGNALS

PARAMETER	ENG. UNIT	ANALOG SIGNALS
TYPE	N/A	Balanced
TRANSFER	N/A	DC Coupled
ANALOG VOLTAGE (line to line)	V	–5 to +5
RIPPLE AND NOISE	mV Peak (1)	± 20
CAPACITY (Maximum)	nF	N/A
IMPEDANCE	Ohm	≤ 1K
OVERVOLTAGE PROTECTION (Min)	V	± 15
FAULT VOLTAGE EMISSION (Max)	V	± 15
FAULT CURRENT LIMIT. (Maximum)	mA	± 10 (2)

Notes: (1) Measurement Bandwidth ≥ 50 MHz

(2) ISPR AAA= 30mA max

3.3.10.2.2 DISCRETE COMMAND BUILT-IN-TEST INTERFACE CHARACTERISTICS

The discrete command built-in-test (BIT) interface characteristics (signal source) shall be in accordance with Table 3.3.10.2.2–1, Electrical Characteristics of BIT Interface.

TABLE 3.3.10.2.2–1 ELECTRICAL CHARACTERISTICS OF THE BIT INTERFACE

PARAMETER	ENG. UNIT	SMOKE SENSOR
TYPE	N/A	Single-Ended
TRANSFER	N/A	DC Coupled
I/F VOLTAGE (TRUE) (line to line)	V	< 1.5
OPERATING CURRENT ON (TRUE) (Max)	mA	2
RIPPLE AND NOISE	mV Peak (1)	± 100
FAULT VOLTAGE EMISSION (Max)	V	± 5
FAULT CURRENT EMISSION (Max)	mA	5

Notes: (1) Measurement Bandwidth ≥ 50 MHz
(2) If interface is active (on or true)

3.3.10.2.3 SMOKE INDICATOR ELECTRICAL INTERFACES

The smoke indicator electrical interface characteristics shall be in accordance with Table 3.3.10.2.3–1, Smoke Indicator Interface Characteristics. The smoke indicator consists of a Light Emitting Diode (LED) located on the ISPR frontside.

TABLE 3.3.10.2.3–1 SMOKE INDICATOR INTERFACE CHARACTERISTICS

PARAMETER	ENG. UNIT	SMOKE INDICATOR
TYPE	N/A	Floating
TRANSFER	N/A	DC Coupled
LOAD CURRENT (max)	mA	10
OVERVOLTAGE PROTECTION RANGE	V	± 20
FAULT CURRENT EMISSION (max)	mA	24
IMPEDANCE (DC)	Ohm	> 650
CAPACITANCE	nF	< 2

Note: At zero current rating (infinite load impedance)

3.3.10.2.4 FAN VENTILATION STATUS ELECTRICAL INTERFACES

The integrated rack fan ventilation status electrical interface characteristics shall be in accordance with paragraph 3.3.10.2.1, Analog Interface Characteristics.

The air is circulated through the smoke sensor in the integrated rack by a fan controlled and powered by the integrated rack.

3.3.10.3 RACK MAINTENANCE SWITCH (RACK POWER SWITCH)/FIRE DETECTION SUPPORT INTERFACE CONNECTOR

A. Integrated rack connector P43 mating requirements to the UIP connector J43 are specified in paragraph 3.1.1.6.1, G.

B. The integrated rack maintenance switch/FDS P43 connector shall meet the pin out interfaces of the UIP J43 connector as specified in SSP 57001, paragraph 3.3.6.

C. Integrated rack maintenance switch/FDS P43 connector shall meet the requirements of SSQ 21635 or equivalent.

3.4 PAYLOAD NTSC VIDEO AND AUDIO INTERFACE REQUIREMENTS

This paragraph is limited to internal video interfaces. The U.S. LAB and APM provides a fiber optic video interface in accordance with paragraph 3.4.1.2, NTSC Fiber Optic Video. The JEM provides an NTSC electrical video interfacing accordance with paragraph 3.4.1.3, NTSC Electrical Video Interface. The MPLM does not have video.

3.4.1 PAYLOAD NTSC VIDEO INTERFACE REQUIREMENTS

3.4.1.1 PAYLOAD NTSC OPTICAL VIDEO CHARACTERISTICS

A. Payload NTSC Optical video characteristics shall be in accordance with Table 3.4.1.1–1, NTSC Video Performance Characteristics.

B. The interpretation shall be in accordance with EIA/TIA RS–250–C End to End NTSC Video for Satellite Transmission System.

C. Video signal to crosstalk noise, shall be in accordance with paragraph 3.19 of NTC–7.

TABLE 3.4.1.1–1 NTSC VIDEO PERFORMANCE CHARACTERISTICS (OPTICAL VIDEO ONLY) (TBR #3)

Characteristic	Point–to Point Path Characteristics			Test Method (per EIA/TIA 250C)
	Value	Recommended	Required	
Amplitude vs. Frequency Response	10 kHz to 300 kHz:	±0.20 dB	±0.40 dB	Para 6.1.1
	3.58 MHz ± 300 kHz :	±0.40 dB	±0.60 dB	
	4.2 MHz:, Monotonic Roll off above 4.2 MHz	±0.70 dB	±0.90 dB	
	10 MHz:	+ 1.0/–3.0 dB	+ 1.30/–3.30 dB	
Chrominance to Luminance Gain Inequality	Nominal	± 3.3 IRE	± 7.0 IRE	Para 6.1.2.1
Chrominance to Luminance Delay Inequality	Nominal	± 21 ns	± 21 ns	Para 6.1.2.2
Luminance Non–Linearity	Nominal	6% Max	6% Max	Para 6.2.1
Differential Gain	Nominal	4% Max	4% Max	Para 6.2.2.1
Differential Phase	Nominal	1.9°	1.9°	Para 6.2.2.2
Signal to Noise Ratio (10 KHz to 5 MHz) (Triangular)	Non–weighted	43.8 dB min	43.8 dB min	Para 6.3.1

3.4.1.2 NTSC FIBER OPTIC VIDEO

3.4.1.2.1 PULSE FREQUENCY MODULATION NTSC FIBER OPTIC VIDEO CHARACTERISTICS

The pulse frequency modulation (PFM) fiber optical video interface consists of one video channel into the rack, one video channel out of the rack, and one synchronization and control channel.

A. The PFM fiber optic video shall be in accordance with paragraph 3.4.1, Payload NTSC Video Characteristics.

B. The PFM fiber optic characteristics shall in accordance with Table 3.4.1.2–1, NTSC Fiber Optic Video Signal Characteristics.

TABLE 3.4.1.2–1 NTSC FIBER OPTIC VIDEO SIGNAL CHARACTERISTICS

PFM Signal Bandwidth	40–72 Megahertz (MHz)
PFM Signal Characteristics	Square wave, FM signal characterized by nominal 50 percent duty cycle
PFM Center Frequency (Blanking Level)	48.57 MHz (0 IRE/0mV)
White Level Frequency	70.25 Mhz (100 IRE/714 mV)
Sync Tip Frequency	40.07 Mhz (–40 IRE/–286 mV)
Blanking Level Variation	+/– 2 Mhz
Video Signal Format	NTSC composite NTSC/EIA–RSA–170A (1)
Pre-emphasis/De-emphasis	per CCIR Recommendation 405 of EIA/TIA–250–C. (1) (2)
Bus Media	Fiber Optics on both SSMB and APM sides
Video Sync	EIA–RS–170A Compliant Black Burst Sync

Notes:

(1) Or any video/data format compatible with PFM characteristics as indicated in this table.

(2) With the emphasis enabled the above set-up results in PFM frequencies of 53.27 MHz for the white level (100 IRE/714 mV), 48.57 MHz for the blanking level (0 IRE/0mv), and 46.67 MHz for sync tip (–40 IRE/–286 mV).

3.4.1.2.2 INTEGRATED RACK NTSC PFM VIDEO TRANSMITTED OPTICAL POWER

The integrated rack that transmits PFM video on the optical video system, with or without an ARIS adapter, shall be designed to transmit a video PFM signal at an average optical power greater than –15.5 dBm.

3.4.1.2.3 INTEGRATED RACK NTSC PFM VIDEO AND SYNC SIGNAL RECEIVED OPTICAL POWER

The integrated rack that receives PFM video and sync signal on the optical video system, with or without an ARIS adapter, shall be designed to receive a PFM video and sync signal at an average optical power greater than –22.2 dBm.

3.4.1.2.4 FIBER OPTIC CABLE CHARACTERISTICS

The video/data and sync signals shall use fiber optic cable in accordance with Table 3.4.1.2.4–1, PFM NTSC Video Optical Fiber Characteristics.

TABLE 3.4.1.2.4–1 PFM NTSC VIDEO OPTICAL FIBER CHARACTERISTICS

Parameter	Dim.	Medium Characteristics
Operating Wave length (min/max)	nm	1270/1380
Fibre Type	–	graded index, multimode
Fibre Core Diameter (min/max)	μm	98/102
Fibre Cladding Diameter (min/max)	μm	138/142
Numerical Aperture (min/max)	–	0.28/0.32
Attenuation @ 1290± 10nm	dB/Km	≤ 4
Modal Bandwidth @ 1290± 10nm	MHz × Km	200
–Signal Timing:		
Optical Rise Time (10% to 90%)	ns	≤ 3.5
Optical Fall Time (10% to 90%)	ns	≤ 3.5
Random Jitter (peak to peak) (1)	ns	≤ 0.76
Data Dependent Jitter (peak to peak) (1)	ns	≤ 0.6
Duty Cycle Distortion (peak to peak) (1)	ns	≤ 1

Note:

(1) These parameter refer to fibre optic data test setup.

3.4.1.2.5 PFM NTSC VIDEO FIBER OPTIC CABLE BEND RADIUS

The integrated rack shall develop the routing, installation and handling procedures to assure the minimum bend radius of 2 inches or greater is maintained at all times for the Fiber Optic Cable.

3.4.1.2.6 DELETED

3.4.1.2.7 PFM NTSC OPTICAL CONNECTOR/PIN ASSIGNMENTS

A. Integrated rack connector P16 mating requirements to the UIP connector J16 are specified in paragraph 3.1.1.6.1, F.

B. The integrated rack PFM NTSC video fiber optic system P16 connector shall meet the pin out interfaces of the UIP J16 connector as specified in SSP 57001, paragraph 3.4.1.2.

C. The integrated rack PFM NTSC video fiber optic system P16 connector shall meet the requirements of SSQ 21635 or equivalent.

3.4.1.3 NTSC ELECTRICAL VIDEO INTERFACES

3.4.1.3.1 CABLES

The cables selected for the transmission of sync and control signals and video and status signals for an ISPR shall be SSQ21655 (NDBC–TFE–22–2SJ–75) or equivalent.

3.4.1.3.2 SIGNAL STANDARD

Integrated racks shall output video and status signals which comply with the signal standard specified in RS–170A at Interface B of Figure 3.4.1.3.2–1 to JEM video system.

Integrated racks will receive sync signal and video signal at Interface A and C of Figure 3.4.1.3.2–1 from the JEM video system which complies with signal characteristic specified in Table 3.4.1.3.2–1.

Note:

(1) Control Line
The control signal from USOS that would be embedded in sync signal can not be sent to the integrated racks in JEM.

(2) Status Line
The video status of USOS standard, which would be embedded in the video out signal from integrated racks, is sent to USOS. The JEM video system does not decode the camera telemetry of the US payloads.

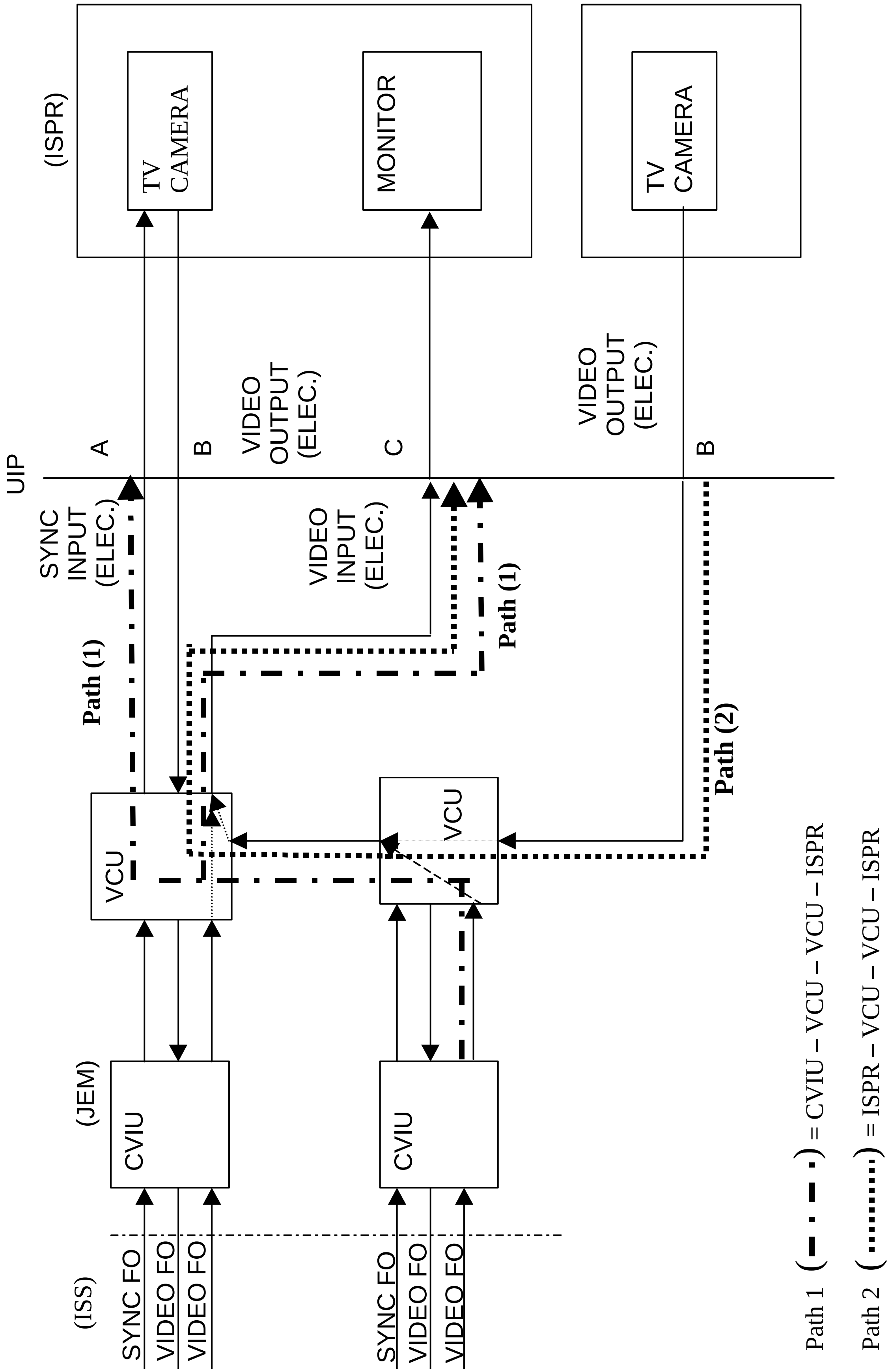


FIGURE 3.4.1.3.2–1 INTERFACE POINT FOR JEM ELECTRICAL VIDEO

TABLE 3.4.1.3.2–1 JEM VIDEO AND SYNC SIGNAL STANDARD

No.	Parameter	Out–Put Video and Status Signals (RS–170A)	*In–Put sync and input video signals (JEM Video System)	Unit	Note
1	Picture Blanking	10.9 ± 0.2	10.9 ± 0.2	μs	
2	Front Porch	1.5 ± 0.1	1.5 ± 0.1	μs	
3	Sync	4.7 ± 0.1	4.7 ± 0.1	μs	
4	H Sync Level	40 ± 2	40 ± 2	IRE	
5	H Sync Rise Time	0.14 ± 0.02	0.14 +0.06/–0.02	μs	
6	H Sync Fall Time	0.14 ± 0.02	0.14 +0.06/–0.02	μs	
7	Burst Amplitude	40 ± 2	40 +2/–15	IRE	
8	Start of Burst	5.3 ± 0.1	5.3 ± 0.1	μs	
9	Burst Cycle	9	9	cycle	
10	SCH	0 ± 40	0 ± 40	deg.	
11	Equalizing Pulse	2.3 ± 0.1	2.3 ± 0.1	μs	
12	Equalizing Pulse Rise Time	0.14 ± 0.02	0.14 +0.06/–0.02	μs	
13	Equalizing Pulse Fall Time	0.14 ± 0.02	0.14 +0.06/–0.02	μs	
14	Vertical Serration	4.7 ± 0.1	4.7 ± 0.1	μs	
15	Vertical Serration Rise Time	0.14 ± 0.02	0.14 +0.06/–0.02	μs	
16	Vertical Serration Fall Time	0.14 ± 0.02	0.14 +0.06/–0.02	μs	

*Note: These values are based on the following paths:

Path 1 = CVIU to VCU to VCU to ISPR (see Figure 3.4.1.3.2–1)

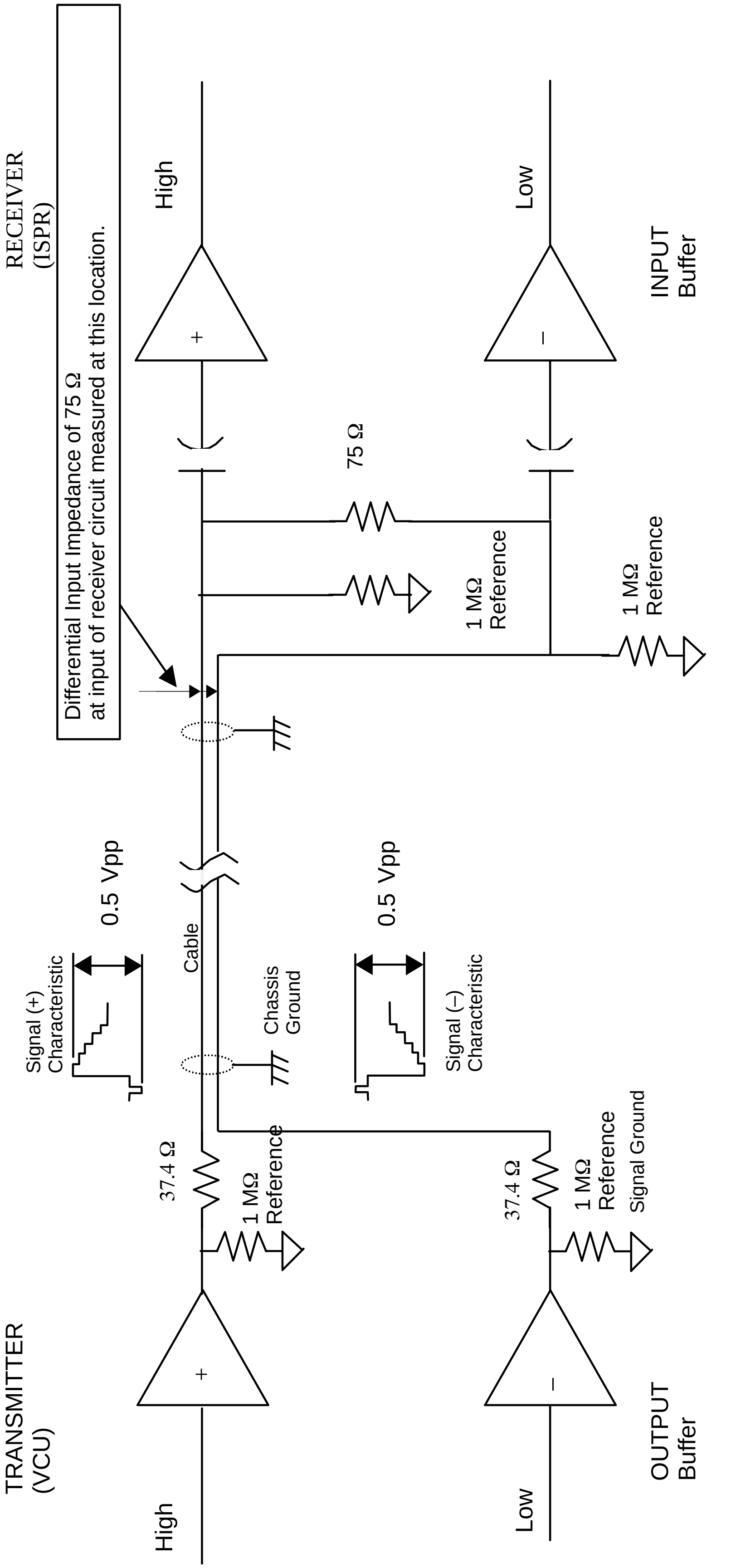
Path 2 = ISPR to VCU to VCU to ISPR (see Figure 3.4.1.3.2–1)

3.4.1.3.3 INTERFACE CIRCUIT

The interface circuit of video system components in the integrated rack for sync, video output and video input shall comply with Figure 3.4.1.3.3–1 or equivalent. This circuit is recommended for a payload where a video interface is required.

3.4.1.3.4 CROSS TALK

The cross talk in the integrated rack shall be less than –50dB.



Notes:
(1) Voltage in the circuit should never exceed the tolerance limits of ± 5.50 VDC even when a single failure occurs.
(2) The coupling capacitor upstream of input buffer may be omitted.
(3) INput load impedance of the receive circuit to cable with respect to ground should be greater than 6 KΩ.

FIGURE 3.4.1.3.3–1 VIDEO/SYNC SIGNAL INTERFACE CIRCUIT

3.4.1.4 NTSC ELECTRICAL CONNECTOR/PIN ASSIGNMENTS

A. Integrated rack connector P77 mating requirements to the ISPR UIP connector J77 are specified in paragraph 3.1.1.6.1, K.

B. The integrated rack electrical video system P77 connector shall meet the pin out interfaces of the UIP J77 connector as specified in SSP 57001, paragraph 3.4.2.1.

C. The integrated rack electrical video system P77 connector shall meet the requirements of SSQ 21635 or equivalent.

3.4.2 U.S. ELEMENT AUDIO INTERFACE REQUIREMENTS

There are no direct audio interfaces from a payload to any ISS equipment. Audible Caution and Warning enunciation is through the Standard safety caution and warning status words.

3.5 THERMAL CONTROL INTERFACE REQUIREMENTS

3.5.1 INTERNAL THERMAL CONTROL SYSTEM (ITCS) INTERFACE REQUIREMENTS

3.5.1.1 PHYSICAL INTERFACE

A. Integrated rack connectors for moderate temperature water cooling supply and return mating requirements to the utility interface panel connectors are specified in paragraph 3.1.1.6.1, items L and M.

B. Integrated rack connectors for low temperature water cooling supply and return mating requirements to the utility interface panel connectors are specified in paragraph 3.1.1.6.1, items N and O.

3.5.1.2 ITCS FLUID CHARGING AND EXPANSION

A. Deleted

B. The integrated rack, non–rack payload, and ORU shall be delivered on–orbit fully charged with ITCS fluid.

C. Integrated racks, non–rack payloads, and ORUs that are not connected to the MPLM Thermal Control System during transport to and from orbit shall provide the capability to compensate for thermal expansion of the ITCS fluid between the temperatures of 34°F (1.1°C) and 115°F (46.1°C). The reference fill temperature is 61°F (16°C) for integrated racks that utilize the moderate temperature loop and 34°F (1.1°C) for integrated racks that utilize the low temperature loop.

D. Integrated racks, non–rack payloads, and ORUs that are disconnected from the on–orbit ITCS system shall provide the capability to compensate for thermal expansion between the temperatures of 61°F (16°C) and 115°F (46.1°C) for moderate temperature loop and 34°F (1.1°C) and 115°F (46.1°C) for low temperature loop.

E. A thermal expansion device that remains connected to the integrated rack, non–rack payload, or ORU fluid system while integrated rack, non–rack payload, or ORU is connected to the on–orbit ITCS, shall actuate at a pressure no less than 100 psia (690 kPa).

3.5.1.3 ITCS PRESSURE DROP

3.5.1.3.1 ON–ORBIT INTERFACES

A. The pressure differential of the integrated rack shall be 5.8 ± 0.2 psid (40 ± 1.4 kPa) at the integrated rack's maximum design flow rate with both halves of each mated QD pair included as part of the payload pressure differential.

B. The integrated rack with operational flow rates less than the maximum design flow rate shall either; 1) when using fixed flow rates (for example, parallel branches within the rack, each with a commandable on/off valve and an orifice), have a pressure differential of 5.8 ± 0.2 psid (40 ± 1.4 kPa) at any of the operational flow rates of the rack with both halves of each mated QD pair included as part of the payload pressure differential, or 2) when using active flow control valves, control the operational flow rate at a constant flow rate given that the pressure differential at the interface is 5.8 ± 0.2 psid (40 ± 1.4 kPa) with both halves of each mated QD pair included as part of the payload pressure differential. Note: MELFI and MSG are exempt from this part B requirement.

3.5.1.3.2 MPLM INTERFACES

The pressure differential of integrated racks actively cooled by the MPLM shall be 2.0 + 0 / – 0.2 psid (13.8 + 0 / – 1.4 kPa) at the integrated rack's maximum design MPLM flow rate with the payload halves of each mated QD pair included as part of the payload pressure differential.

3.5.1.4 COOLANT FLOW RATE

A. Moderate Temperature Loop

The integrated rack shall be designed to meet the moderate temperature loop allowable flow rate specified in paragraph 3.5.1.2 of the Pressurized Payload Hardware Interface Control Document, SSP 57001.

B. Low Temperature Loop

The integrated rack shall be designed to meet the low temperature loop allowable flow rate specified in paragraph 3.5.1.2 of the Pressurized Payload Hardware Interface Control Document, SSP 57001.

3.5.1.5 COOLANT SUPPLY TEMPERATURE

A. Moderate Temperature Loop

The integrated rack will be designed to meet the moderate temperature loop coolant supply temperature specified in paragraph 3.5.1.3 of the Pressurized Payload Hardware Interface Control Document, SSP 57001.

B. Low Temperature Loop

The integrated rack will be designed to meet the low temperature loop coolant supply temperature specified in paragraph 3.5.1.3 of the Pressurized Payload Hardware Interface Control Document, SSP 57001.

3.5.1.6 COOLANT RETURN TEMPERATURE

A. Integrated racks using moderate temperature coolant at operating modes above 1025 watts, shall have a minimum differential temperature across the integrated rack (inlet to outlet) of 19.5°C (35°F).

B. Integrated racks using moderate temperature coolant shall be designed to operate using 100 lbm/hr flow during operating modes which require less than 1025 watts of power.

C. The maximum moderate temperature coolant return temperature shall be no greater than 49°C (120°F).

D. The maximum low temperature coolant return temperature shall be no greater than 21°C (70°F).

3.5.1.7 COOLANT MAXIMUM DESIGN PRESSURE

A. Moderate Temperature Loop

The integrated rack shall withstand the moderate temperature loop maximum design pressure of 121 psia (834 kPa).

B. Low Temperature Loop

The integrated rack shall withstand the low temperature loop maximum design pressure of 121 psia (834 kPa).

C. MPLM Temperature Loop

Integrated racks requiring active cooling in the MPLM shall withstand the active thermal control loop maximum design pressure of 210 psia (1448 kPa). The maximum design pressure is derived from an Orbiter Freon loop/Payload Heat Exchanger failure condition, the MPLM coolant will be a mixture of water and Freon 21.

3.5.1.8 FAIL SAFE DESIGN

The integrated racks shall assess the payload equipment and rack internal water loop piping to ensure that it is fail safe in the case of loss of cooling under all modes of operation.

3.5.1.9 LEAKAGE

A. The integrated rack shall not exceed the maximum rack leakage rate of water of $14x10^{-3}$ scc/ hr (liquid) per each thermal loop at the MDP of 121 psia (834 kPa).

B. Integrated Refrigerator and Freezer racks that operate in the MPLM shall not exceed the maximum leakage rate of water of $9x10^{-3}$ scc/ hr (liquid) for 72 hours when exposed to 100% Freon–21 in the water lines at the MDP of 210 psia (1,448 kPa).

3.5.1.10 QUICK-DISCONNECT AIR INCLUSION

Payload Quick Disconnects shall not exceed the maximum air inclusion of .30 cubic centimeters (cc) maximum per couple/uncouple cycle.

3.5.1.11 RACK FRONT SURFACE TEMPERATURE

The integrated rack shall be designed such that the average front surface temperature is less than 37°C (98.6°F) and partial limit not to exceed 49°C (120°F).

3.5.1.12 CABIN AIR HEAT LEAK

The sensible heat leak to the cabin air from the integrated rack either alone or together with the other ISPRs simultaneously active will not exceed the limits specified in paragraph 3.5.1.8 of the Pressurized Payload Hardware Interface Control Document, SSP 57001. These limits represent the total cabin air heat load capability when the cabin temperature is at 18°C (65°F). The numbers in this Table are the total cabin heat load allocation for all the ISPR's on a module basis.

3.5.1.13 MPLM CABIN AIR COOLING

Absorption of heat from the cabin air by integrated racks operating in the MPLM shall be no greater than the maximum values listed in Table 3.5.1.13–1, with linear interpolation to ambient temperatures between the specified values.

TABLE 3.5.1.13–1 MPLM CABIN AIR HEAT ABSORPTION

<table>
<tr><th rowspan="3">Ambient
Temperature</th><th colspan="4">Rack–level Heat Absorption from MPLM Cabin Air (Watts)</th><th rowspan="3">MPLM
Limit* (Watts)</th></tr>
<tr><th rowspan="2">Crew
Refrigerator/ Freezer Rack (R/FR)</th><th colspan="2">MELFI Rack</th><th rowspan="2">CRYO SYSTEM Transportation Rack (Cryogenic Storage Freezer)</th></tr>
<tr><th>1 Dewar at –80°C (–112°F)</th><th>4 Dewars at –80°C (–112°F)</th></tr>
<tr><td>60°F (15.6°C)</td><td>60 W</td><td></td><td></td><td></td><td>254 W</td></tr>
<tr><td>68°F (20°C)</td><td></td><td>24 W</td><td>68 W</td><td>16 W</td><td></td></tr>
<tr><td>85°F (29.4°C)</td><td>77 W</td><td></td><td></td><td></td><td>317 W</td></tr>
<tr><td>120°F (48.9°C)</td><td>140 W</td><td>29 W</td><td>85 W</td><td>20 W</td><td>526 W</td></tr>
</table>

* This is maximum heat absorption by all refrigerated rack (R/FRs, MELFIs and Cryo Freezers) from the MPLM cabin air.

3.5.1.14 SIMULTANEOUS COOLING

A. Integrated racks requiring simultaneous moderate and low temperature flow shall be compatible with the thermal control system simultaneous flow interfaces specified in paragraph 3.5.1.5 of the Pressurized Payload Hardware Interface Control Document SSP 57001.

B. The moderate temperature loop and low temperature loop coolant flow shall not be mixed together.

3.5.1.15 CONTROL SYSTEM TIME CONSTANT

Integrated racks containing automated flow control systems shall be designed such that set point changes resulting in flow rate changes greater than five pounds mass flow per hour (5 lbm/hr) shall take at least 100 seconds to reach 63.2% (i.e., $1 - e^{-1}$) of the commanded change in flow rate.

3.5.1.16 PAYLOAD COOLANT QUANTITY

Integrated racks shall contain no more than the maximum allowable coolant quantity of water, referenced at 61°C (141.8°F), as specified in paragraph 3.5.1.6 of the Pressurized Payload Hardware Interface Control Document SSP 57001.

3.6 VACUUM SYSTEM REQUIREMENTS

3.6.1 VACUUM EXHAUST SYSTEM (VES)/WASTE GAS SYSTEM (WGS) REQUIREMENTS

3.6.1.1 VES/WGS PHYSICAL INTERFACE

Integrated rack connectors for the VES/WGS mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, Q.

3.6.1.2 INPUT PRESSURE LIMIT

A. Integrated racks shall limit their vented exhaust gas to a pressure of 276 kPa (40 psia) or less at the rack to Station interface.

B. Integrated rack volumes connected to the VES/WGS shall be designed to a maximum design pressure of at least 276 kPa (40 psia) with safety factors in accordance with SSP 52005 paragraph 5.1.3.

C. The integrated rack shall be two failure tolerant to protect against failure conditions which would exceed VES/WGS max design pressure of 40 psia.

3.6.1.3 INPUT TEMPERATURE LIMIT

The initial temperature range of exhaust gases shall be between 16°C (60°F) to 45°C (113°F).

3.6.1.4 INPUT DEWPOINT LIMIT

The initial dewpoint of exhaust gases shall be limited to 16°C (60°F) or less.

3.6.1.5 ACCEPTABLE EXHAUST GASES

A. Integrated rack exhaust gases vented into the VES/WGS of the USL, APM, and JEM shall be compatible with the wetted surface materials of the respective laboratory(ies) in which the integrated rack will operate, as defined in SSP 41002, paragraph 3.3.7.2.

Note: The integrated rack is responsible for providing containment, storage, and transport hardware for gases that are incompatible with the vacuum exhaust or external environment. Where applicable, containment hardware for incompatible exhaust gases must meet the redundant container requirements specified in NSTS 1700.7, ISS Addendum, section 209.1b.

B. Integrated rack gases vented to the ISS VES/WGS shall be non–reactive with other vent gas mixture constituents.

C. Integrated racks venting to the ISS VES/WGS shall provide a means of removing gases that would adhere to the ISS VES/WGS tubing walls at a wall temperature or 4°C (40°F) and at a pressure of 10^{-3} torr.

D. Integrated racks venting to the ISS VES/WGS shall remove particulates from vent gases that are larger than 100 micrometers in size.

3.6.1.5.1 ACCEPTABLE GASES – LIST

A. A list of acceptable exhaust gases with verified compatibility to the USL VES wetted materials is specified in Appendix D1 and a list of unacceptable gases that are not compatible with the USL VES is specified in Appendix D2.

B. A list of acceptable exhaust gases with verified compatibility to the JEM WGS wetted materials is specified in Appendix D3 and a list of unacceptable gases that are not compatible with the JEM WGS is specified in Appendix D4.

C. A list of acceptable exhaust gases with verified compatibility to the APM WGS wetted materials is specified in Appendix D5 and a list of unacceptable gases that are not compatible with the APM WGS is specified in Appendix D6.

3.6.1.5.2 EXTERNAL CONTAMINATION CONTROL

Exhaust gases shall be compatible with paragraph 3.4 of SSP 30426, Space Station External Contamination Control Requirements, for molecular column density, particulates, and deposition on external Space Station surfaces.

3.6.1.6 PAYLOAD VACUUM SYSTEM ACCESS VALVE

Integrated racks using the ISS VES/WGS system shall provide a vacuum system access valve in the integrated rack system to isolate the integrated rack experiment chamber from the ISS VES/WGS system when the integrated rack is not venting to the ISS VES/WGS. This requirement does not apply to integrated racks venting only the constituents of cabin air, noble gases or ISS pressurized gases.

Note: The Rack Isolating Valve (RIV) in the ISS VES/WGS system at the rack location must be open prior to opening the integrated rack vacuum system access valve. The positions of the RIVs in the US Lab are available to the rack in the ancillary data.

3.6.2 VACUUM RESOURCE SYSTEM (VRS)/VACUUM VENT SYSTEM (VVS) REQUIREMENTS

3.6.2.1 VRS/VVS PHYSICAL INTERFACE

Integrated rack connectors for the VRS/VVS mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, R.

3.6.2.2 INPUT PRESSURE LIMIT

A. Integrated racks shall limit their vented VRS/VVS gases to a pressure of 10^{-3} torr or less at the rack to Station interface.

B. Integrated rack volumes connected to the VRS/VVS shall be designed to a maximum design pressure of at least 276 kPa (40 psia) with safety factors in accordance with SSP 52005 paragraph 5.1.3.

C. The integrated rack shall be two failure tolerant to protect against failure conditions which would exceed VRS/VVS max design pressure of 40 psia.

3.6.2.3 VRS/VVS THROUGHPUT LIMIT

Integrated racks shall limit their gas throughput to the VRS/VVS to less than 1.2 x 10^{-3} torr liters/second.

3.6.2.4 ACCEPTABLE GASES

Vacuum gases which have been verified to be compatible with the VES/WGS are compatible with the VRS/VVS. Acceptable gases are defined in section 3.6.1.5.1.

Note: Gases at 10^{-3} torr or below are compatible with the VRS/VVS.

3.7 PRESSURIZED GASES INTERFACE REQUIREMENTS

3.7.1 NITROGEN INTERFACE REQUIREMENTS

3.7.1.1 NITROGEN INTERFACE CONTROL

A. The integrated rack shall provide a valve, located within the integrated rack envelope, to turn on and off the flow of nitrogen to the integrated rack.

B. The integrated rack shall provide a means to control the flow of nitrogen to not exceed 5.43 kg/hr (12 lbm/hr) when connected to the nitrogen interface operating pressure range of 517 to 827 kPa (75 to 120 psia).

3.7.1.2 NITROGEN INTERFACE MDP

The MDP of the integrated rack nitrogen system shall be 1,379 kPa (200 psia).

3.7.1.3 NITROGEN INTERFACE TEMPERATURE

The integrated rack nitrogen system will be designed for a nitrogen supply temperature range of 15.6°C to 45°C (60°F to 113°F).

3.7.1.4 NITROGEN LEAKAGE

The integrated rack shall have a nitrogen leakage rate no greater than 10^{-3} scc/sec at MDP. Leakage is considered to be loss to the cabin atmosphere associated with quick disconnects, fittings, seals, valves, and permeation through materials from, and including, the standoff UIP connection to the nitrogen on/off flow control point in the integrated rack. All nitrogen flowing past the on/off flow control point is considered usage. The integrated rack allocation for nitrogen will comprise leakage and usage.

3.7.1.5 NITROGEN PHYSICAL INTERFACE

Integrated rack connectors for the nitrogen system mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, P.

3.7.2 ARGON INTERFACE REQUIREMENTS

3.7.2.1 ARGON INTERFACE CONTROL

A. The integrated rack shall provide a valve, located within the integrated rack envelope, to turn on and off the flow of argon to the integrated rack.

B. The integrated rack shall provide a means to control the flow of argon to not exceed 2.14 kg/hr (4.71 lbm/hr) when connected to the argon interface operating pressure range of 517 to 786 kPa (75 to 114 psia).

3.7.2.2 ARGON INTERFACE MDP

The MDP of the integrated rack argon system shall be 1,379 kPa (200 psia).

3.7.2.3 ARGON INTERFACE TEMPERATURE

The integrated rack argon system will accept an argon supply temperature range of 13°C to 45°C (55.4°F to 113°F).

3.7.2.4 ARGON LEAKAGE

The integrated rack shall have an argon leakage rate no greater than 10^{-3} scc/sec at MDP. Leakage is considered to be loss to the cabin atmosphere associated with quick disconnects, fittings, seals, valves, and permeation through materials from, and including, the standoff UIP connection to the argon on/off flow control point in the integrated rack. All argon flowing past the on/off flow control point is considered usage. The integrated rack allocation for argon will comprise leakage and usage.

3.7.2.5 ARGON PHYSICAL INTERFACE

Integrated rack connectors for the argon system mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, S.

3.7.3 CARBON DIOXIDE INTERFACE REQUIREMENTS

3.7.3.1 CARBON DIOXIDE INTERFACE CONTROL

A. The integrated rack shall provide a valve, located within the integrated rack envelope, to turn on and off the flow of carbon dioxide to the integrated rack.

B. The integrated rack shall provide a means to control the flow of carbon dioxide to not exceed 0.59 kg/hr (1.30 lbm/hr) when connected to the carbon dioxide interface operating pressure range of 517 to 786 kPa (75 to 114 psia).

3.7.3.2 CARBON DIOXIDE INTERFACE MDP

The MDP of the integrated rack carbon dioxide system shall be 1,379 kPa (200 psia).

3.7.3.3 CARBON DIOXIDE INTERFACE TEMPERATURE

The integrated rack carbon dioxide system will accept a carbon dioxide supply temperature range of 13°C to 45°C (55.4°F to 113°F).

3.7.3.4 CARBON DIOXIDE LEAKAGE

The integrated rack shall have a carbon dioxide leakage rate no greater than 10^{-3} scc/sec at MDP. Leakage is considered to be loss to the cabin atmosphere associated with quick disconnects, fittings, seals, valves, and permeation through materials from, and including, the standoff UIP connection to the carbon dioxide on/off flow control point in the integrated rack. All carbon dioxide flowing past the on/off flow control point is considered usage. The integrated rack allocation for carbon dioxide will comprise leakage and usage.

3.7.3.5 CARBON DIOXIDE PHYSICAL INTERFACE

Integrated rack connectors for the carbon dioxide system mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, U.

3.7.4 HELIUM INTERFACE REQUIREMENTS

3.7.4.1 HELIUM INTERFACE CONTROL

A. The integrated rack shall provide a valve, located within the integrated rack envelope, to turn on and off the flow of helium to the integrated rack.

B. The integrated rack shall provide a means to control the flow of helium to not exceed 0.21 kg/hr (0.47 lbm/hr) when connected to the helium interface operating pressure range of 517 to 786 kPa (75 to 114 psia).

3.7.4.2 HELIUM INTERFACE MDP

The MDP of the integrated rack helium system shall be 1,379 kPa (200 psia).

3.7.4.3 HELIUM INTERFACE TEMPERATURE

The integrated rack helium system will accept a helium temperature range of 13°C to 45°C (55.4°F to 113°F).

3.7.4.4 HELIUM LEAKAGE

The integrated rack shall have a helium leakage rate no greater than 10^{-3} scc/sec at MDP. Leakage is considered to be loss to the cabin atmosphere associated with quick disconnects, fittings, seals, valves, and permeation through materials from, and including, the standoff UIP connection to the helium on/off flow control point in the integrated rack. All helium flowing past the on/off flow control point is considered usage. The integrated rack allocation for helium will comprise leakage and usage.

3.7.4.5 HELIUM PHYSICAL INTERFACE

Integrated rack connectors for the helium system mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, T.

3.7.5 PRESSURIZED GAS SYSTEMS

Pressurized gas systems with a total expanded gas volume exceeding 400 liters at Standard Conditions shall limit the gas flow after a single failure to less than 240 SLPM after 400 liters at Standard Conditions has been released to the cabin air.

3.7.6 MANUAL VALVES

If a manual valve is employed for control of a pressurized gas, the valve shall be accessible without rack rotation.

3.8 PAYLOAD SUPPORT SERVICES INTERFACES REQUIREMENTS

3.8.1 POTABLE WATER

3.8.1.1 POTABLE WATER INTERFACE CONNECTION

Integrated rack connectors for the potable water system mating requirements are specified in paragraph 3.1.1.6.1, V.

Payload-provided containers used to convey water from the Space Shuttle Orbiter prior to the deployment of the ISS potable water processor, the ISS galley, and the ISS fuel-cell water tank on-orbit will be compatible with the Orbiter water interfaces.

3.8.1.2 POTABLE WATER INTERFACE PRESSURE

The payload-provided container, and all tubing, hoses and connectors used to connect to the ISS potable water interface shall not visibly leak when exposed to the ISS potable water interface pressure of 103.4 to 206.8 kPa gauge pressure (15 to 30 psig).

3.8.1.3 POTABLE WATER USE

A. The integrated rack use of water from the ISS water system that is not returned to the cabin air as humidity shall not exceed a daily average of 2.2 kg/day (4.8 lbm/day) based upon weekly usage.

B. The total use of water by the integrated rack from the ISS water system, including A and all water returned to the cabin air as humidity, shall be limited to not exceed a daily average of 5.51 kg/day (12.15 lbm/day) based upon weekly usage.

Payload water use from the Space Shuttle Orbiter prior to the deployment of the ISS potable water processor, the ISS galley, and the ISS fuel-cell water tank on-orbit will be limited by fuel-cell water reserves available from the Orbiter after crew habitability needs have been addressed.

3.9 ENVIRONMENT INTERFACE REQUIREMENTS

3.9.1 ATMOSPHERE REQUIREMENTS

3.9.1.1 PRESSURE

The integrated rack shall be safe when exposed to pressures of 0 to 104.8 kPa (0 to 15.2 psia).

3.9.1.2 TEMPERATURE

The integrated rack shall be safe when exposed to temperatures of 10 to 46°C (50 to 115°F).

3.9.1.3 HUMIDITY

The integrated rack shall be designed to not cause condensation when exposed to the ISS atmosphere ranging in dewpoint from 4.4 to 15.6°C (40 to 60°F) and in relative humidity from 25 to 75%, except when condensation is an intended operation of the integrated rack. For reference, Figure 3.9.1.3–1 depicts the temperature/humidity envelope defined by these dewpoint and relative humidity ranges for air (21% oxygen, 79% nitrogen) at one atmosphere pressure (14.7 psia).

3.9.2 INTEGRATED RACK USE OF CABIN ATMOSPHERE

3.9.2.1 ACTIVE AIR EXCHANGE

A. Active air exchange with the cabin atmosphere by rack and sub-rack payloads shall be limited to air exchange for specimen metabolic purposes and for mass conservation purposes.

B. Active air exchange with the cabin atmosphere by aisle mounted payloads shall comply with paragraph 3.5.1.12.

3.9.2.2 OXYGEN CONSUMPTION

The integrated rack consumption of atmospheric oxygen shall not exceed 1.08 kg per day (2.38 lbm per day).

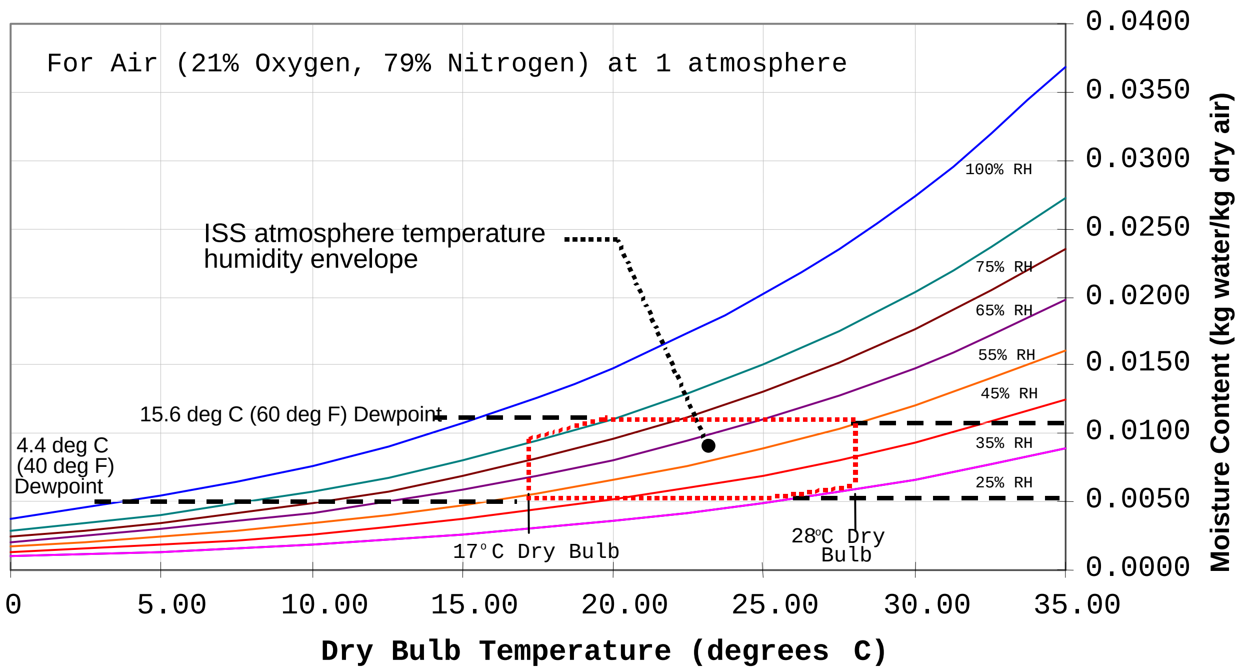


FIGURE 3.9.1.3–1 ISS TEMPERATURE/HUMIDITY ENVELOPE

3.9.2.3 CHEMICAL RELEASES

Chemical releases to the cabin air shall be in accordance with paragraphs 209.1a and 209.1b in NSTS 1700.7, ISS Addendum.

3.9.3 RADIATION REQUIREMENTS

3.9.3.1 INTEGRATED RACK CONTAINED OR GENERATED IONIZING RADIATION

Integrated racks containing or using radioactive materials or that generate ionizing radiation shall comply with NSTS 1700.7, ISS Addendum, paragraph 212.1.

3.9.3.2 IONIZING RADIATION DOSE

Integrated racks should expect a total dose (including trapped protons and electrons) of 30 Rads(Si) per year of ionizing radiation. A review of the dose estimates in the ISS (SAIC–TN–9550 may show ionizing radiation exposure to be different than 30 Rads(Si) per year, if the intended location of the rack in the ISS is known.

3.9.3.3 SINGLE EVENT EFFECT (SEE) IONIZING RADIATION (TBR #6)

Equipment and subsystems shall be designed not to produce an unsafe condition or one that could cause damage to equipment external to the integrated rack as a result of exposure to SEE ionizing radiation assuming exposure levels specified in SSP 30512, paragraph 3.2.1, with a shielding thickness of 25.4 mm (1000 mils).

3.9.3.4 LAB WINDOW RACK LOCATION RADIATION REQUIREMENTS

The requirements in the section apply only to the integrated rack at the lab window location, and only when the protective shield on the window is removed.

TABLE 3.9.3.4–1 SOLAR RADIATION

Wavelength Range (nm)	Solar Irradiance (W–cm^2–um^1)	Allowed Transmittance
220–240	0.005	<0.01%
240–280	0.02	<0.01%
280–300	0.055	<1.0%
300–320	0.115	<1.0%
850–1000	decays linearly from 0.12 (@ 850 nm) to 0.09 (@ 1000 nm)	<10%

3.9.3.4.1 WINDOW RACK INFRARED RADIATION REQUIREMENTS

When the lab window scratch pane is removed, shielding shall be provided for protection of the crew that reduces the infrared transmittance to less than 10.0 percent of the environment specified in Table 3.9.3.4–1 for wavelengths between 850 and 1000 nanometers.

3.9.3.4.2 WINDOW RACK ULTRAVIOLET RADIATION REQUIREMENTS

When the lab window scratch pane is removed, shielding shall be provided for protection of the crew that reduces the Ultraviolet transmittance to less than 0.01 percent for wavelengths between 220 and 280 nanometers and less than 0.1 percent for wavelengths between 280 and 320 nanometers for the environment specified in Table 3.9.3.4–1.

3.9.4 ADDITIONAL ENVIRONMENTAL CONDITIONS

The environmental information provided in Table 3.9.4–1 and Figure 3.9.4–1 is for design and analysis purposes.

TABLE 3.9.4–1 ENVIRONMENTAL CONDITIONS

Environmental Condition	Value	
Atmospheric Conditions on ISS		
Pressure Extremes	0 to 104.8 kPa (0 to 15.2 psia)	
Normal operating pressure	See Figure 3.9.4–1	
Oxygen partial pressure	See Figure 3.9.4–1	
Nitrogen partial pressure	See Figure 3.9.4–1	
Dewpoint	4.4 to 15.6°C (40 to 60°F) ref. Figure 3.9.1.3–1	
Percent relative humidity	25 to 75% ref. Figure 3.9.1.3–1	
Carbon dioxide partial pressure during normal operations with 6 crewmembers plus animals	24-hr average exposure 5.3 mm Hg Peak exposure 7.6 mm Hg	
Carbon dioxide partial pressure during crew changeout with 11 crewmembers plus animals	24-hr average exposure 7.6 mm Hg Peak exposure 10 mm Hg	
Cabin air temperature in USL, JEM, APM, and CAM	17 to 28°C (63 to 82°F)	
Cabin air temperature in Node 1	17 to 31°C (63 to 87°F)	
Air velocity (Nominal)	0.051 to 0.203 m/s (10 to 40 ft/min)	
Airborne microbes	Less than 1000 CFU/m3	
Atmosphere particulate level	Average less than 100,000 particles/ft3 for particles less than 0.5 microns in size	
MPLM Air Temperatures	**Passive Flights**	**Active Flights**
Pre-Launch	15 to 24°C (59 to 75.2°F)	14 to 30°C (57.2 to 86°F)
Launch/Ascent	14 to 24°C (57.2 to 75.2°F)	20 to 30°C (68 to 86°F)
On-orbit (Cargo Bay + Deployment)	24 to 44°C (75.2 to 111.2°F)	16 to 46°C (60.8 to 114.8°F)
On-orbit (On-Station)	23 to 45°C (73.4 to 113°F)	16 to 43°C (60.8 to 109.4°F)
On-orbit (Retrieval + Cargo Bay)	17 to 44°C (62.6 to 111.2°F)	11 to 45°C (51.8 to 113°F)
Descent/Landing	13 to 43°C (55.4 to 109.4 °F)	10 to 42°C (50 to 107.6°F)
Post-Landing	13 to 43°C (55.4 to 109.4 °F)	10 to 42°C (50 to 107.6°F)
Ferry Flight	15.5 to 30°C (59.9 to 86 °F)	15.5 to 30°C (59.9 to 86°F)
MPLM Maximum Dewpoint Temperatures		
Pre-Launch	13.8°C (56.8°F)	12.5°C (54.5°F)
Launch/Ascent	13.8°C (56.8°F)	12.5°C (54.5°F)
On-orbit (Cargo Bay + Deployment)	13.8°C (56.8°F)	12.5°C (54.5°F)
On-orbit (On-Station)	15.5°C (60°F)	15.5°C (60°F)
On-orbit (Retrieval + Cargo Bay)	10°C (50°F)	10°C (50°F)
Descent/Landing	10°C (50°F)	10°C (50°F)
Post-Landing	10°C (50°F)	10°C (50°F)
Ferry Flight	15.5°C (60°F)	15.5°C (60°F)
Thermal Conditions		
USL module wall temperature	13°C to 43°C (55°F to 109°F)	
JEM module wall temperature	13°C to 45°C (55°F to 113°F) **(TBR #7)**	
APM module wall temperature	13°C to 43°C (55°F to 109°F) **(TBR #8)**	
CAM module wall temperature	13°C to 43°C (55°F to 109°F) **(TBR #9)**	
Other integrated payload racks	Front surface less than 37 °C (98.6°F)	
General Illumination	108 Lux (10 fc) measured 30 inches from the floor in the center of the aisle	

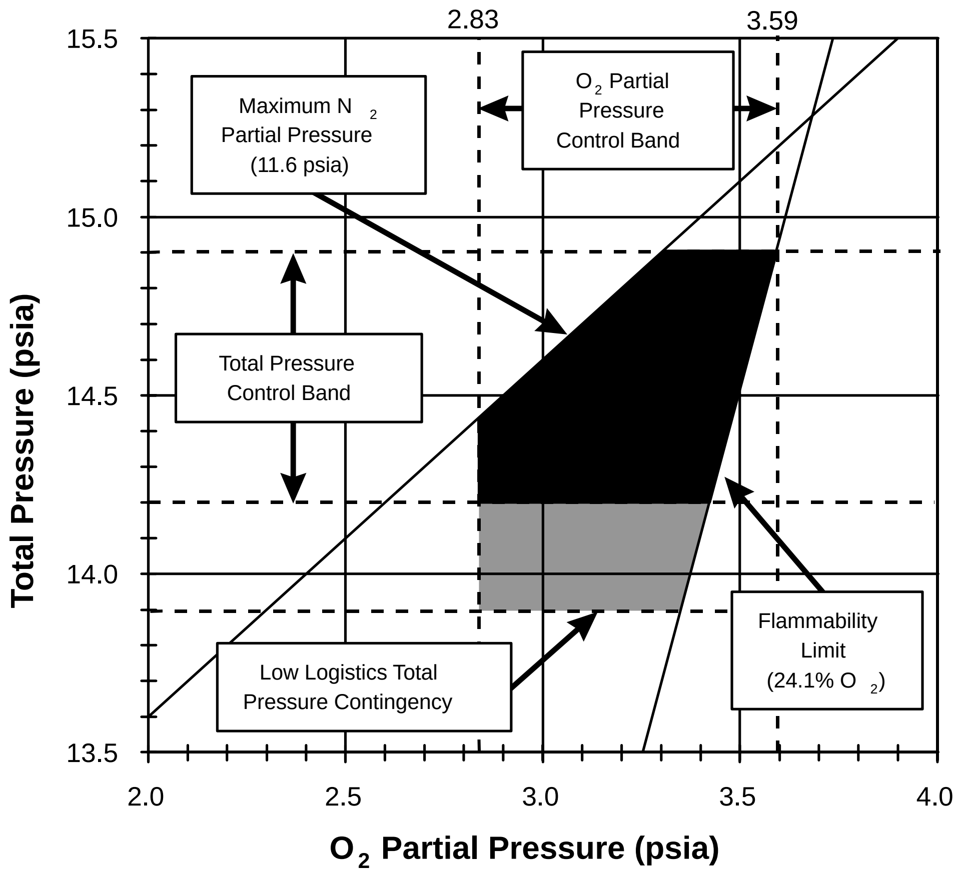


FIGURE 3.9.4–1 OPERATING LIMITS OF THE ISS ATMOSPHERIC TOTAL PRESSURE, AND NITROGEN AND OXYGEN PARTIAL PRESSURES

3.10 FIRE PROTECTION INTERFACE REQUIREMENTS

3.10.1 FIRE PREVENTION

Integrated racks and aisle mounted equipment shall meet the fire prevention requirements specified in NSTS 1700.7, ISS Addendum, paragraph 220.10a.

3.10.2 PAYLOAD MONITORING AND DETECTION REQUIREMENTS

Safety monitoring and detection requirements are specified in NSTS 1700.7 ISS Addendum, paragraph 220.10b.

Note: Integrated racks will be classified as one of four types: 1) single forced airflow volumes, 2) multiple separate forced airflow volumes, 3) a combination forced airflow volume(s) / no forced airflow volumes(s) and 4) no forced airflow volumes. For a single forced airflow volume integrated rack, the ISS monitors and detects fire events within payloads containing potential fire sources by using a station approved rack smoke detector. For multiple separate forced airflow volumes (which do not exchange air with the other volumes), the main avionics area will monitor and detect fire events with the station approved smoke detector and other volumes with forced airflow will use parameter monitoring. For combination forced airflow volume(s) / no forced airflow volume(s), the forced airflow volume containing the main avionics area in the integrated rack will use parameter monitoring. For integrated racks that contain a potential fire source but do not have any forced airflow volumes, parameter monitoring will be used as an alternative. Use of parameter monitoring will be presented to and approved by the PSRP during the phased safety reviews. Volumes containing no potential fire sources do not require detection capabilities. Aisle mounted equipment (laptop computers, etc.) which rely on module smoke detectors for fire event detection, will not require internal fire event detection capabilities.

3.10.2.1 SMOKE DETECTION

3.10.2.1.1 SMOKE DETECTOR

A. Integrated racks that contain potential fire source and have forced air circulation shall use a smoke detector that meets the requirements specified in SSP 30262:013.

Note 1: The ISS common smoke sensor part numbers are Allied Signal P/N 2351520–2–1 or P/N 2119818–3–1 for area type, or Allied Signal P/N 2351510–2–1 or P/N 2119814–3–1 for duct type.

Note 2: Detection of a fire event with the smoke detector constitutes a Class 1 – Emergency per 3.3.5.1.4.1.1.

B. Integrated racks requiring a smoke detector shall provide a smoke detector interface at the J43 connection with interface characteristics meeting the requirements specified in paragraph 3.3.10.

3.10.2.1.2 FORCED AIR CIRCULATION INDICATION

Integrated racks requiring a smoke detector shall provide a signal and data indicating the presence of airflow in the velocity range of 3 to 36.6 meters per minute (10 to 120 feet per minute) for the Area Smoke Detector (Allied Signal [Honeywell] P/N 2351520–2–1 or 2119818–3–1) or 18.3 to 603.5 meters per minute (60 to 1980 feet per minute) for the Duct Smoke Detector (Allied Signal [Honeywell] P/N 2351510–2–1 or 22119814–3–1) when the smoke detector is in use.

3.10.2.1.3 FIRE DETECTION INDICATOR

A. Integrated racks requiring a smoke detector shall provide a red Fire Detection Indicator LED in an easily visible location on the front of the rack that is powered by the ISS when the smoke detector senses smoke.

B. Integrated racks requiring a fire detection indicator shall provide a fire detection indicator interface at the J43 connection with interface characteristics meeting the requirements specified in paragraph 3.3.10.

3.10.2.2 PARAMETER MONITORING (TBR #10)

3.10.2.2.1 PARAMETER MONITORING USE

Integrated rack or sub-rack volumes that contain a potential fire source and do not exchange air with the rack smoke detector because no forced air circulation is present, or for metabolic or science isolation purposes shall provide sensors that will monitor that volume to detect a potential fire event.

Note 1: The type, number and location of the sensors as well as the determination of whether or not the volume contains a potential fire source will be presented to and approved by the PSRP during the phased safety reviews.

Note 2: Detection of a potential fire event in these volumes constitutes a Class 2 – Warning per 3.3.5.1.4.1.2.

3.10.2.2.2 PARAMETER MONITORING RESPONSE

3.10.2.2.2.1 PARAMETER MONITORING IN SUB–RACK

A. The integrated rack shall provide manual and automatic capabilities to terminate forced air circulation (if present) and power to each sub-rack volume/payload that is monitored with parameter monitoring.

Note: For integrated racks where the payload MDM provides the monitoring function, the P/L MDM is capable of sending a command to the rack to command the rack to power off the sub–rack volume/payload to meet the automatic requirement if negotiated in the Software ICD.

B. The integrated rack shall respond to a potential fire event within a separate, sub-rack volume/payload that is monitored with parameter monitoring by sending data to indicate the location of the potential fire event, data indicating which parameter annunciated the potential fire event and data for evaluating the potential fire event condition to the payload MDM in the format specified in paragraph 3.3.5.1.4.A.

C. The integrated rack shall respond to a potential fire event within a separate, sub–rack volume/payload that is monitored with parameter monitoring by sending a Class 2 – Warning word to the payload MDM in the format specified in paragraph 3.3.5.1.4.B.

3.10.2.2.2.2 PARAMETER MONITORING IN INTEGRATED RACK

A. Integrated racks only using parameter monitoring shall provide manual and automatic capabilities to terminate forced air circulation (if present) and power to the integrated rack.

Note: Use of the PCS (connected to the Command and Control MDM) meets the manual requirement in all modules. For integrated racks where the payload MDM provides the monitoring function, the P/L MDM is capable of sending a command to the module RPC that will power off the rack to meet the automatic requirement if negotiated in the unique software ICD and with the Module Integrator.

B. Integrated racks only using parameter monitoring shall respond to a potential fire event by sending data to indicate the location of the potential fire event, data indicating which parameter annunciated the potential fire event and data for evaluating the potential fire event condition to the payload MDM in the format specified in paragraph 3.3.5.1.4.A.

C. The integrated rack shall respond to a potential fire event that is monitored with parameter monitoring by sending a Class 2 – Warning word to the payload MDM in the format specified in paragraph 3.3.5.1.4.B.

3.10.3 FIRE SUPPRESSION

Note: Each separate integrated rack and sub-rack equipment volume which contains a potential fire source will require fire suppression capabilities. Determination of potential fire sources will be presented to and approved by the PSRP during the phased safety reviews. Safety fire suppression requirements are specified in NSTS 1700.7, ISS Addendum, paragraph 220.10c.

3.10.3.1 PORTABLE FIRE EXTINGUISHER

A. Integrated rack and sub-rack enclosed volumes that have a panel thickness less than or equal to 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is between 12.7 mm (0.5 inch) and 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 3.1.1.4–1.

B. Integrated rack and sub-rack enclosed volumes that have a panel thickness greater than 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 3.1.1.4–1.

Note 1: The final determination of whether or not a payload volume contains a potential fire source and requires a PFE access port will be presented to and approved by the PSRP during the phased safety reviews.

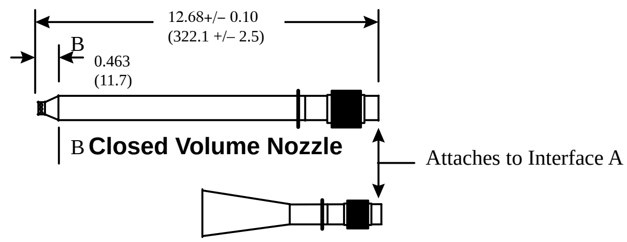
Note 2: The ISS PFE has an “open cabin” diffuser nozzle which will be used to surround fire events that are not in an enclosed volume with suppressant.

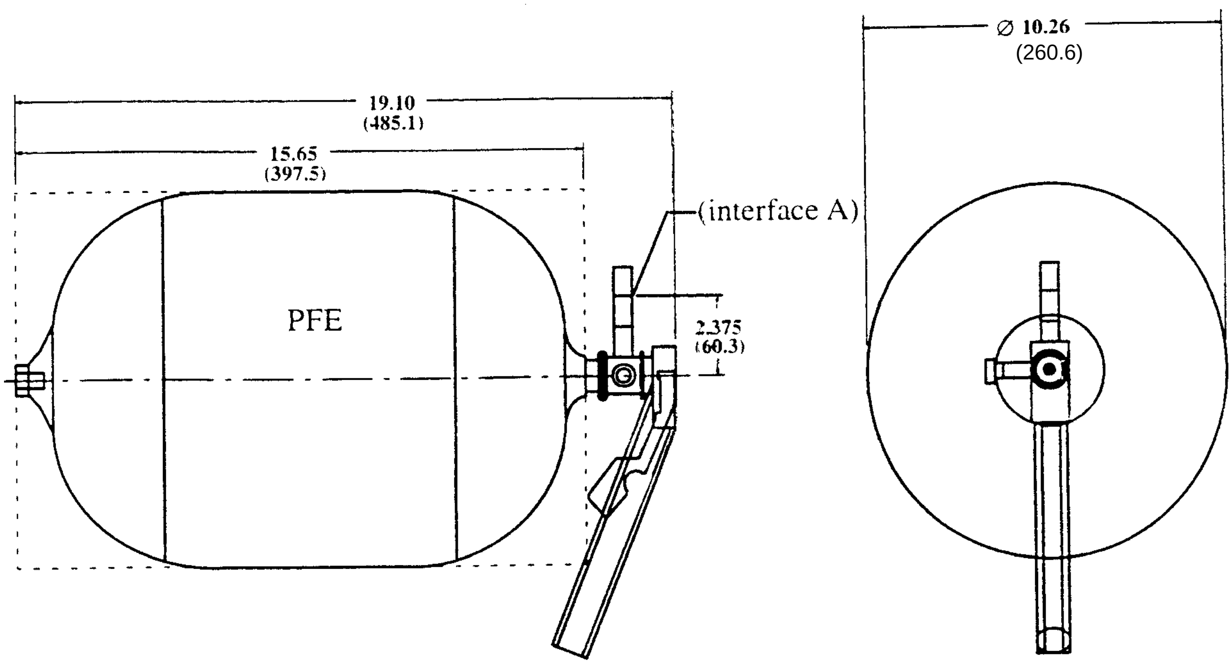
Note 3: Internal volumes are volumes presented to and approved by the PSRP as sealed containers do not require PFE access ports.

3.10.3.2 FIRE SUPPRESSION ACCESS PORT ACCESSIBILITY

Each integrated rack requiring an access port shall have a front face designed to accommodate the PFE nozzle and bottle specified in Figures 3.10.3.2–1 and 3.10.3.2–2 so the PFE nozzle can interface to the PFE port.

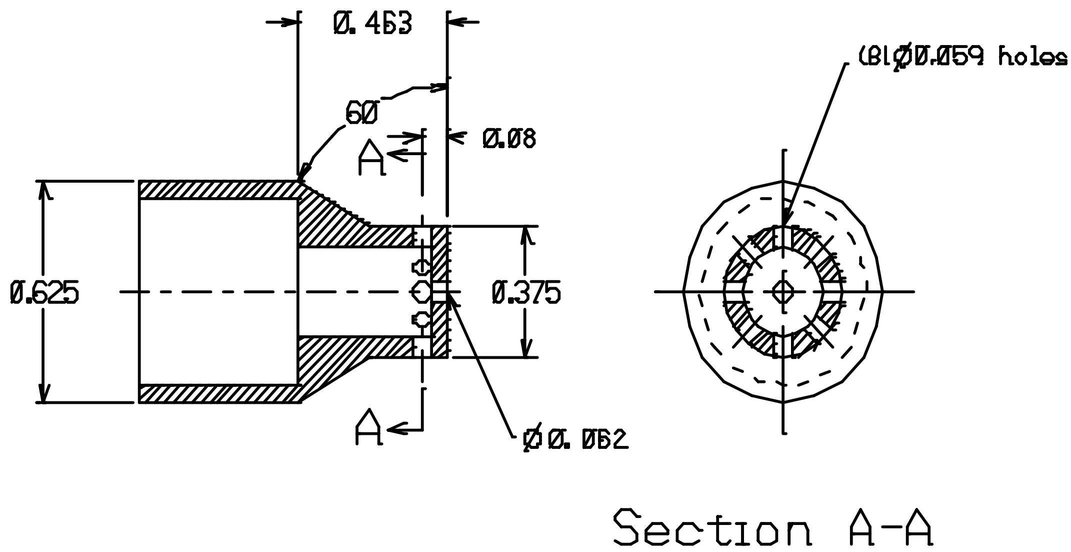
Closed volume nozzle dimensions specified in Figure 3.10.3.2–2





Note: Measurements from PFE centerline to point B with the closed cabin Nozzle attached is approximately 14.59 inches (370.6 mm)

FIGURE 3.10.3.2–1 MANUAL FIRE SUPPRESSION HARDWARE ENVELOPE



Note: Linear dimensions are in inches, angular dimensions are in degrees.

FIGURE 3.10.3.2–2 CLOSED VOLUME PFE NOZZLE

3.10.3.3 FIRE SUPPRESSANT DISTRIBUTION

The internal layout of integrated racks shall allow ISS PFE fire suppressant to be distributed to the entire volume that PFE Access Port serves, lowering the Oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute. Volumes specified in section 3.10.3.4 do not apply to this requirement.

Note: The position of integrated rack internal components near the PFE Access Port should not prevent fire suppressant to be discharged into the volume the PFE Access Port serves. PFE discharge characteristics are specified in Figure 3.1.1.4–1 and PFE closed volume nozzle dimensions are specified in Figure 3.10.3.2–2.

3.10.4 LABELING

A. Integrated racks requiring an access port shall label the PFE access port with a SDD32100397–003 or SDD32100397–004 “Fire Hole Decal” as specified in JSC 27260, “Decal Process Document and Catalog”.

B. Integrated racks requiring a Fire Detection Indicator LED shall label the Fire Detection Indicator LED “SMOKE INDICATION” as specified in MSFC–STD–275, using 3.96mm

(0.156 inch) letters, style Futura Demibold, and color 37038 (Lusterless Black) per FED–STD–595.

3.11 MATERIALS AND PARTS INTERFACE REQUIREMENTS

3.11.1 MATERIALS AND PARTS USE AND SELECTION

Integrated racks shall use materials and parts that meet the material requirement specified in NSTS 1700.7, ISS Addendum. This requirement also applies to all Commercial/Off The Shelf (COTS) parts used in integrated racks.

3.11.2 FLUIDS (TBR #14)

3.11.2.1 FLUID CHEMICAL COMPOSITION

A. Integrated racks connecting to ISS LTL and MTL fluid systems shall use ITCS fluid that meet the requirements specified in SSP 30573B, Table 4.1–2.8.

B. Integrated racks connecting to ISS nitrogen fluid system shall be charged with nitrogen that meets the requirements specified in SSP 30573B, Table 4.1–2.13, to a pressure no greater than 70 psia (480 kPa).

C. Integrated racks connecting to ISS argon fluid system shall be charged with argon that meets the requirements specified in SSP 30573B, Table 4.1–2.5, to a pressure no greater than 70 psia (480 kPa).

D. Integrated racks connecting to ISS carbon dioxide fluid system shall be charged with carbon dioxide that meets the requirements specified in SSP 30573B, Table 4.1–2.7, to a pressure no greater than 70 psia (480 kPa).

E. Integrated racks connecting to ISS helium fluid system shall be charged with helium that meets the requirements specified in SSP 30573B, Table 4.1–2.9, to a pressure no greater than 70 psia (480 kPa).

3.11.2.2 FLUID SYSTEM CLEANLINESS

A. Integrated rack fluid system connecting to the ISS LTL and MTL fluid systems shall meet the fluid system cleanliness levels specified in SSP 30573B, Table 4.1–1.9.2.

B. Integrated rack fluid systems connecting to the ISS nitrogen fluid system shall meet the fluid system cleanliness levels specified in SSP 30573B, Table 4.1–1.6, Operational Fluids.

C. Integrated rack fluid systems connecting to the ISS argon fluid system shall meet the fluid system cleanliness levels specified in SSP 30573B, Table 4.1–1.6, Operational Fluids.

D. Integrated rack fluid systems connecting to the ISS carbon dioxide fluid system shall meet the fluid system cleanliness levels specified in SSP 30573B, Table 4.1–1.6, Operational Fluids.

E. Integrated rack fluid systems connecting to the ISS helium fluid system shall meet the fluid system cleanliness levels specified in SSP 30573B, Table 4.1–1.6, Operational Fluids.

3.11.2.3 THERMAL COOLING SYSTEM WETTED MATERIALS

A. Integrated racks using ISS aqueous fluid systems (LTL or MTL) shall use internal materials that are compatible according to MSFC–SPEC–2250, Table III or that will not create a potential greater than 0.25 Volts with the ISS system internal materials due to a dissimilar metal couple. This is in accordance with SSP 30233, paragraph 4.5.4, Corrosion Prevention and Control.

B. The integrated racks connected to the LTL or MTL shall be composed of wetted materials that do not include aluminum alloys nor alloys with greater than 5% copper. The LTL and MTL heat transport fluid is designed for use with stainless steel, nickel base and titanium alloys. This is in accordance with SSP 30573B, Table 4.1–2.8, Note 10.

C. The integrated rack systems connected to the LTL or MTL non–metallic wetted surfaces shall be composed of materials that are non–nutrient to fungal growth inside the LTL or MTL systems. This is in accordance with SSP 30233, paragraph 4.10.2, Moisture and Fungus Resistance, and SSP 30573B, Table 4.1–2.8, Note 11.

3.11.3 CLEANLINESS

Integrated racks shall conform to Visibly Clean-Sensitive (VC–S) cleanliness requirements as specified in SN–C–0005.

3.11.4 FUNGUS RESISTANT MATERIAL

Integrated racks that are intended to remain on-orbit for more than one year shall use fungus resistant materials according to the requirements specified in SSP 30233, paragraph 4.2.10.

3.11.5 PYROTECHNICS

Note: Payloads requiring the use of pyrotechnics must meet the safety requirements defined in NSTS/ISS 1700.7B Addendum, paragraph 210, Pyrotechnics. Successful implementation and verification will be accomplished through the payload safety review process.

3.12 HUMAN FACTORS INTERFACE REQUIREMENTS

3.12.1 STRENGTH REQUIREMENTS

Forces and torque’s required to remove, replace, operate, control, and maintain payload hardware and equipment on-orbit shall be equal to or less than the strength values given below.

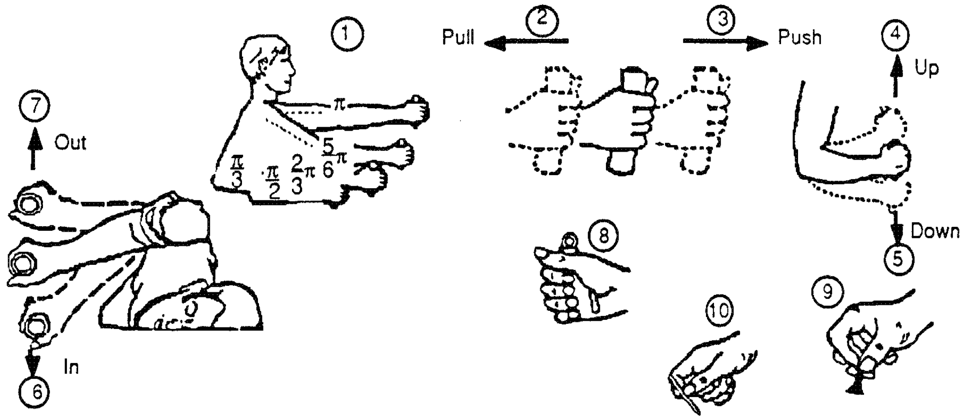
A. For operation and control of payload hardware equipment:

(1) Grip Strength – To remove, replace and operate payload hardware, grip strength required shall be less than 254 N (57lbf).

(2) Linear Forces – Linear forces required to operate or control payload hardware or equipment shall be less than the strength values for the 5th percentile female, defined as 50% of the strength values shown in Figure 3.12.1–1 and 60% of the strength values shown in Figure 3.12.1–2.

(3) Torques – Torques required to operate or control payload hardware or equipment shall be less than the strength values for the 5th percentile female, defined as 60% of the calculated 5th percentile male capability shown in Figure 3.12.1–3.

B. Forces required for maintenance of payload hardware and equipment shall be less than the 5th percentile male strength values shown in Figures 3.12.1–1, 3.12.1–2, 3.12.1–3, 3.12.1–4, and 3.12.1–5.



Arm strength (N)

(1)	(2)		(3)		(4)		(5)		(6)		(7)	
Degree of elbow flexion (rad)	Pull		Push		Up		Down		In		Out	
	L**	R**	L	R	L	R	L	R	L	R	L	R
π	222	231	187	222	40	62	58	76	58	89	36	62
5/6 π	187	249	133	187	67	80	80	89	67	89	36	67
2/3 π	151	187	116	160	76	107	93	116	89	98	45	67
1/2 π	142	165	98	160	76	89	93	116	71	80	45	71
1/3 π	116	107	96	151	67	89	80	89	76	89	53	76

Hand and thumb-finger strength (N)

	(8)		(9)	(10)
	Hand grip		Thumb-finger grip (Palmer)	Thumb-finger grip (tips)
	L	R		
Momentary hold	250	260	60	60
Sustained hold	145	155	35	35

* Elbow angle shown in radians
** L = Left; R = Right

Arm strength (lb)

(1)	(2)		(3)		(4)		(5)		(6)		(7)	
Degree of elbow flexion (deg)	Pull		Push		Up		Down		In		Out	
	L	R*	L	R	L	R	L	R	L	R	L	R
180	50	52	42	50	9	14	13	17	13	20	8	14
150	42	56	30	42	15	18	18	20	15	20	8	15
120	34	42	26	36	17	24	21	26	20	22	10	15
90	32	37	22	36	17	20	21	26	16	18	10	16
60	26	24	22	34	15	20	18	20	17	20	12	17

Hand, and thumb-finger strength (lb)

	(8)		(9)	(10)
	Hand grip		Thumb-finger grip (Palmer)	Thumb-finger grip (tips)
	L	R		
Momentary hold	56	59	13	13
Sustained hold	33	35	8	8

* Left; R = Right

FIGURE 3.12.1–1 ARM, HAND, AND THUMB/FINGER STRENGTH (5TH PERCENTILE MALE DATA)

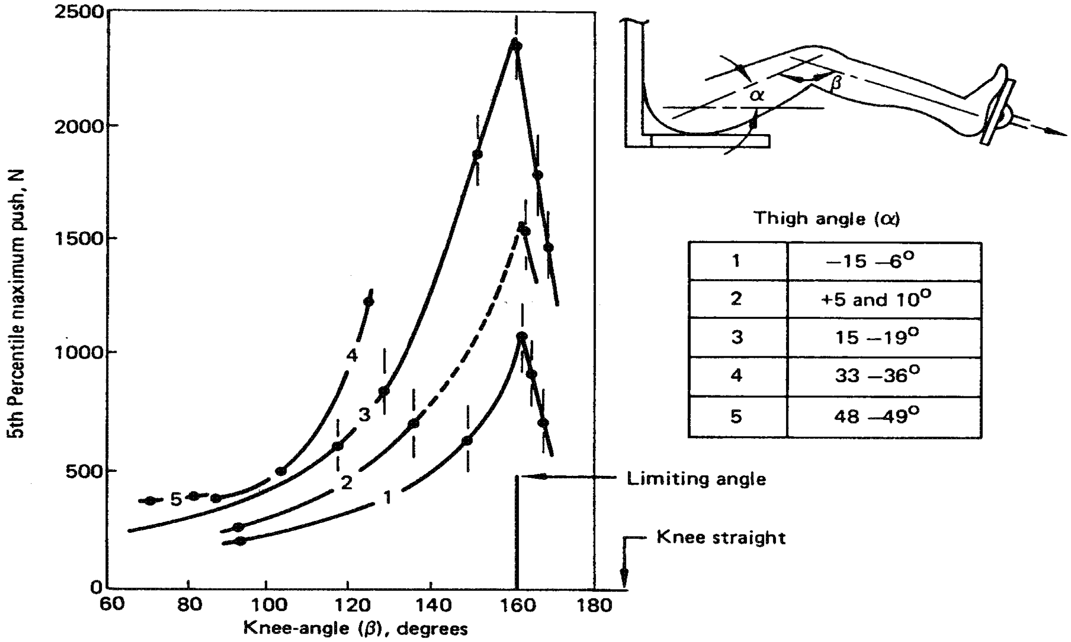


FIGURE 3.12.1–2 LEG STRENGTH AT VARIOUS KNEE AND THIGH ANGLES (5TH PERCENTILE MALE DATA)

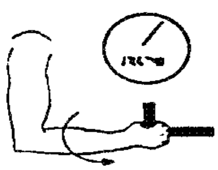
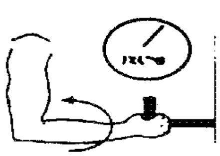
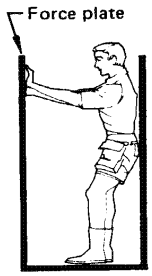
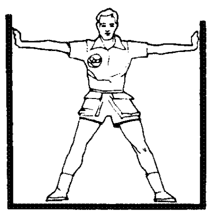
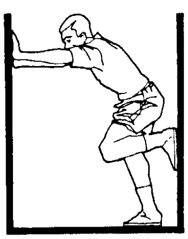
		Unpressurized suit, bare handed	
		Mean	SD
	Maximum torque: Suppination, Nm (lb-in.)	13.73 (121.5)	3.41 (30.1)
	Maximum torque: Pronation, Nm (lb-in.)	17.39 (153.9)	5.08 (45.0)

FIGURE 3.12.1–3 TORQUE STRENGTH

	Force-plate (1) height	Distances (2)	Force, N (lbf) Means	Force, N (lbf) SD
			Both hands	
	100 percent of shoulder height	50	583 (131)	142 (32)
		60	667 (150)	160 (36)
		70	983 (221)	271 (61)
		80	1285 (289)	400 (90)
		90	979 (220)	302 (68)
		100	645 (145)	254 (57)
			Preferred hand	
		50	262 (59)	67 (15)
		60	298 (67)	71 (16)
		70	360 (81)	98 (22)
		80	520 (117)	142 (32)
		90	494 (111)	169 (38)
		100	427 (96)	173 (39)
		Percent of thumb-tip reach *		
	100 percent of shoulder height	50	369 (83)	138 (31)
		60	347 (78)	125 (28)
		70	520 (117)	165 (37)
		80	707 (159)	191 (32)
		90	325 (73)	133 (30)
		Percent of span **		
	Force-plate (1) height	**Distances (2)**	**Force, N (lbf) Means**	**Force, N (lbf) SD**
	50	100	774 (174)	214 (48)
	50	120	778 (175)	165 (37)
	70	120	818 (184)	138 (31)
	Percent of shoulder height		1-g applicable data	

NOTES:

(1) Height of the center of the force plate - 200 mm (8 in) high by 254 mm (10 in) long - upon which force is applied.

(2) Horizontal distance between the vertical surface of the force plate and the opposing vertical surface (wall or footrest, respectively) against which the subject brace themselves.

() Thumb-tip reach - distance from backrest to tip of subject’s thumb as thumb and fingertips are pressed together.

() Span - the maximal distance between a person’s fingertips as he extends his arms and hands to each side.

(3) 1-g data.

FIGURE 3.12.1–4 MAXIMAL STATIC PUSH FORCES

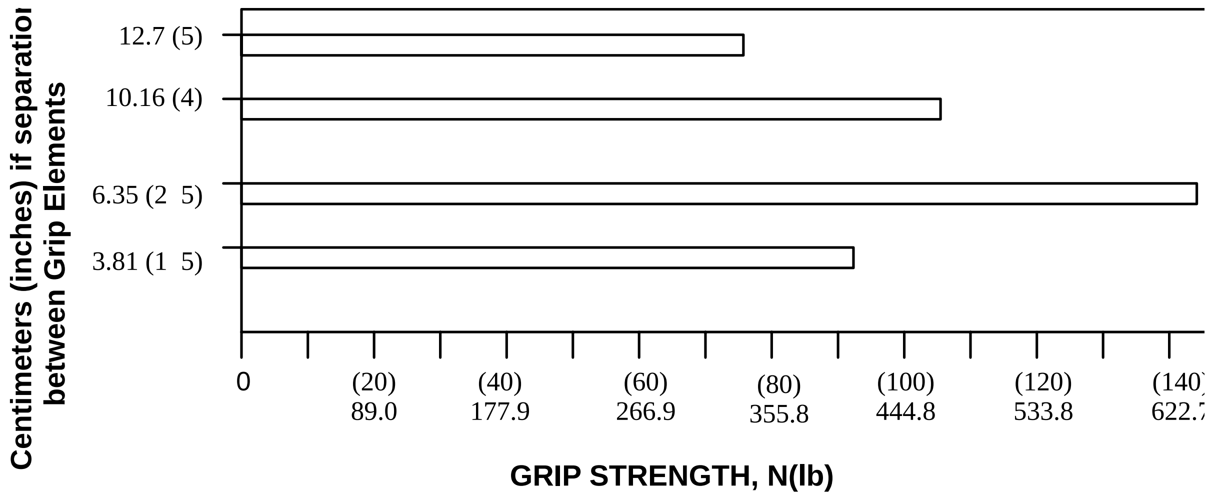


FIGURE 3.12.1–5 MALE GRIP STRENGTH AS A FUNCTION OF THE SEPARATION BETWEEN GRIP ELEMENTS

3.12.2 BODY ENVELOPE AND REACH ACCESSIBILITY

3.12.2.1 ADEQUATE CLEARANCE

The integrated rack shall provide clearance for the crew to perform installation, operations, and maintenance tasks, including clearance for hand access, tools and equipment used in these tasks.

3.12.2.2 ACCESSIBILITY

A. Payload hardware shall be geometrically arranged to provide physical and visual access for all payload installation, operations, and maintenance tasks. Payload ORUs should be removable along a straight path until they have cleared the surrounding structure.

B. IVA clearances for finger access shall be provided as given in Figure 3.12.2.2–1.

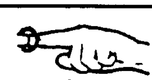
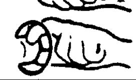
Minimal finger-access to first joint			
Push button access:	Bare hand: Thermal gloved hand:	32 mm dia (1.26 in) 38 mm dia (1.5 in)	
Two finger twist access:	Bare hand: Thermal gloved hand:	object plus 50 mm (1.97 in) object plus 65 mm (2.56 in)	

FIGURE 3.12.2.2–1 MINIMUM SIZES FOR ACCESS OPENINGS FOR FINGERS

3.12.2.3 FULL SIZE RANGE ACCOMMODATION

All payload workstations and hardware having crew nominal operations and planned maintenance shall be sized to meet the functional reach limits for the 5th percentile Japanese female and yet shall not constrict or confine the body envelope for the 95th percentile American male as specified in SSP 50005, section 3.

3.12.3 HABITABILITY

3.12.3.1 HOUSEKEEPING

3.12.3.1.1 CLOSURES OR COVERS

Closures or covers shall be provided for any area of the payload that is not designed for routine cleaning.

3.12.3.1.2 BUILT-IN CONTROL

A. Payload containers of liquids or particulate matter shall have built-in equipment/methods for control of vaporization, material overflow, or spills.

B. The capture elements, including grids, screens, or filter surfaces shall be accessible for replacement or cleaning without dispersion of the trapped materials.

3.12.3.1.3 DELETED

3.12.3.1.4 DELETED

3.12.3.1.5 ONE-HANDED OPERATION

Cleaning equipment and supplies shall be designed for one-handed operation or use.

3.12.3.2 TOUCH TEMPERATURE

3.12.3.2.1 CONTINUOUS/INCIDENTAL CONTACT - HIGH TEMPERATURE

When integrated rack surfaces whose temperature exceeds 49°C (120°F), which are subject to continuous or incidental contact, are exposed to crewmember’s bare skin contact, protective equipment shall be provided to the crew and warning labels shall be provided at the surface site. This also applies to surfaces not normally exposed to the cabin in accordance with the NASA IVA Touch Temperature Safety interpretation letter JSC, MA2–95–048.

3.12.3.2.2 CONTINUOUS/INCIDENTAL CONTACT – LOW TEMPERATURE

When Integrated rack surfaces below –18°C (0°F), which are subject to continuous or incidental contact, are exposed to crewmember's bare skin contact, protective equipment shall be provided to the crew and warning labels shall be provided at the surface site. This also applies to surfaces not normally exposed to the cabin in accordance with the NASA IVA Touch Temperature Safety interpretation letter JSC, MA2–95–048.

3.12.3.3 ACOUSTIC REQUIREMENTS

An Integrated Rack (see Glossary of Terms) will not be allowed to operate above NC–40 except in those cases when it meets the Intermittent Noise Source requirements specified in section 3.12.3.3.2.

Due to the multitude of payload operations, an integrated rack may exhibit multiple acoustic noise source characteristics. These characteristics affect the requirements an integrated rack must satisfy in order to operate on-orbit.

For example, an integrated rack which operates less than eight hours in any one 24–hour period and generates a SPL equal to or in excess of 37 decibels (dBA) measured at 0.6 meter distance from the noisiest part of the rack, is an Intermittent Noise Source. An integrated rack which produces intermittent noise will need to ensure the cumulative time it generates intermittent noise within a 24–hour period satisfies the Intermittent Noise Limit requirements. An integrated rack which operates for more than eight hours in a 24–hour period and generates a SPL equal to or in excess of 37 decibels (dBA) measured at 0.6 meter distance from the noisiest part of the rack is a Continuous Noise Source. An integrated rack which produces continuous noise will be allowed to operate under certain conditions: 1.) if the noise level of the integrated rack always stays below NC–40, or 2.) if the cumulative time it generates noise above NC–40 during any 24–hour period satisfies the Intermittent Noise Limit requirements (see Figure 3.12.3.3–1).

Each Integrated Rack will submit an Acoustics Noise Control Plan (ANCP). The ANCP will identify all testing and analysis required to manage the noise produced by the rack throughout its operational life span on the ISS.

The acoustic limits that will be utilized are provided in the tables which follow. The limits apply to the integrated rack of equipment and, to any sub-rack equipment that is independently operated outside of the rack. The integrated rack configuration includes any adjunct equipment such as payload-provided external computers, fans, etc., added in support of the rack system.

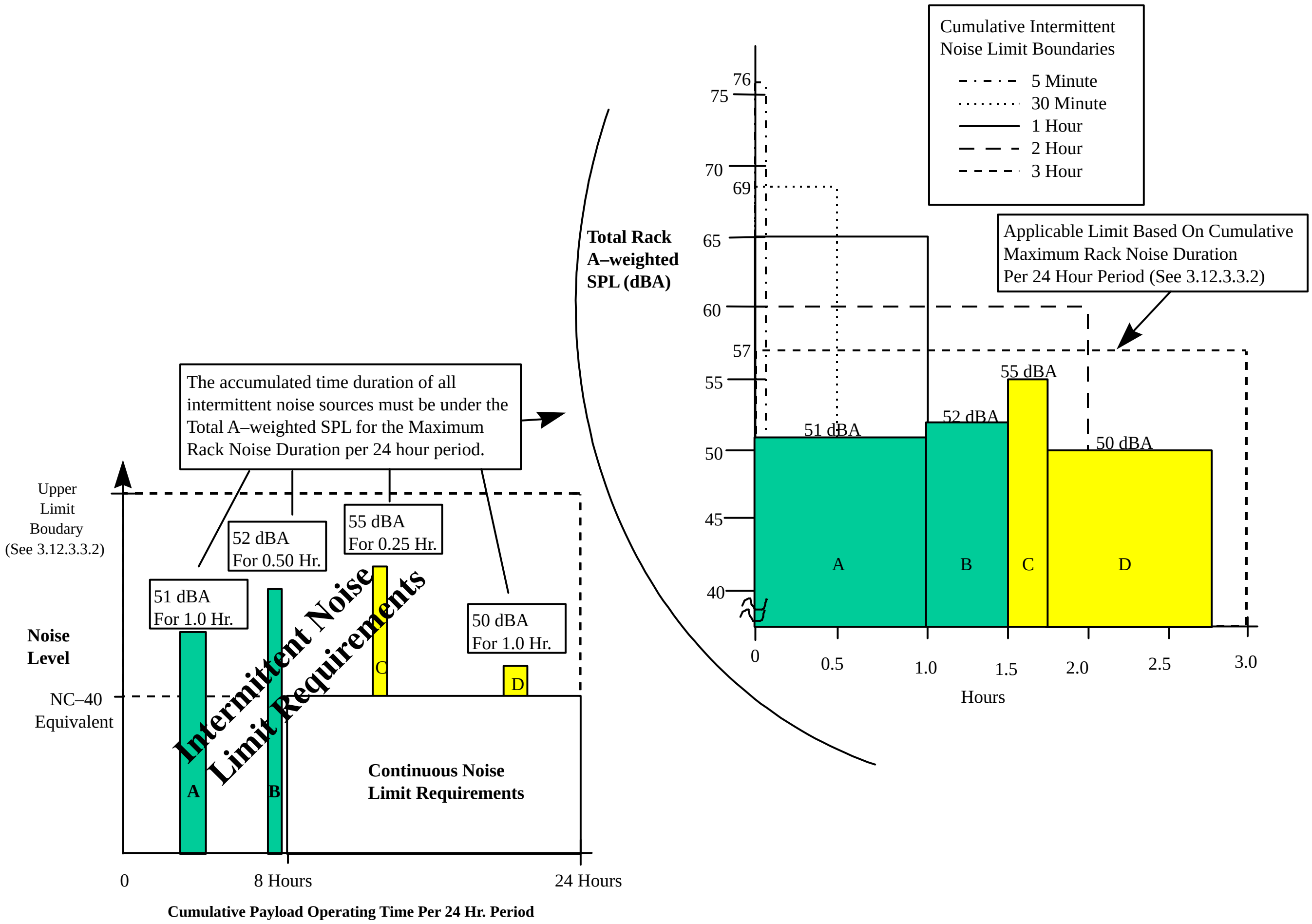


FIGURE 3.12.3.3–1 INTERMITTENT NOISE LIMIT REQUIREMENTS

3.12.3.3.1 CONTINUOUS NOISE LIMITS

A. **Integrated Racks Whose Sub–Rack Equipment Will Not Be Changed Out** – The Continuous Noise Source (see Glossary of Terms) for an integrated rack (including any supporting adjunct active portable equipment operated outside the integrated rack that is within or interfacing with the crew habitable volume) whose sub-rack equipment will not be changed out on-orbit shall not, except in those cases when the rack meets the Intermittent Noise Source requirements specified in section 3.12.3.3.2, exceed the limits specified in Table 3.12.3.3.1–1 for all octave bands (NC–40 equivalent) when the equipment is operating in the loudest expected configuration and mode of operation that can occur on orbit under nominal crew, or hardware operation circumstances, during integrated rack setup operations, or during nominal operations where doors/panels are opened or removed. NOTE: These acoustic requirements do not apply during failure or maintenance operations.

B. **Integrated Racks Whose Sub–Rack Equipment Will Be Changed Out** – The Continuous Noise Source (see Glossary of Terms) for an integrated rack (including any supporting adjunct active portable equipment operated outside the integrated rack that is within or interfacing with the crew habitable volume) whose sub-rack equipment will be changed out on-orbit shall not, except in those cases when the rack meets the Intermittent Noise Source requirements specified in section 3.12.3.3.2, exceed the limits specified in Table 3.12.3.3.1–1 for all octave bands (NC–40 equivalent) when the equipment is operating in the loudest expected configuration and mode of operation that can occur on orbit under nominal crew, or hardware operation circumstances, during integrated rack setup operations, or during nominal operations where doors/panels are opened or removed. NOTE: These acoustic requirements do not apply during failure or maintenance operations.

C. **Independently Operated Equipment** – Any independently operated (e.g. UOP) equipment designed to operate within the habitable volume and not part of any integrated rack system shall individually comply with the acoustic requirements in Table 3.12.3.3.1–2.

D. **Integrated Racks That Have Crew Operations Within the Rack Volume** – In addition to the noise requirements of paragraph 3.12.3.3.1 (A) and (B), the noise level at expected head positions in an ISPR occupied by a crew member for nominal payload operations, shall not exceed the limits specified in Table 3.12.3.3.1–3 for all octave bands (NC–50 equivalent).

TABLE 3.12.3.3.1–1 CONTINUOUS NOISE LIMITS

Rack Noise Limits Measured At 0.6 Meters Distance From The Test Article	
Frequency Band Hz	**Integrated Rack Sound Pressure Level (SPL)**
63	64
125	56
250	50
500	45
1000	41
2000	39
4000	38
8000	37

TABLE 3.12.3.3.1–2 NOISE LIMITS FOR INDEPENDENTLY OPERATED EQUIPMENT

Noise Limit at 0.6 Meters Distance From Equipment (NC 34)	
Frequency Band (Hz)	**Sound Pressure Level (SPL)**
63	59
125	52
250	45
500	39
1000	35
2000	33
4000	32
8000	31

TABLE 3.12.3.3.1–3 INTERNAL RACK VOLUME CONTINUOUS NOISE LIMITS

Noise Limits At the Nominal Location of a Crew Member's Head During Payload Operations	
Frequency Band Hz	**Integrated Rack Sound Pressure Level (SPL) (dB)**
63	71
125	64
250	59
500	54
1000	51
2000	49
4000	48
8000	47

3.12.3.3.2 INTERMITTENT NOISE LIMITS

A. **Integrated Racks that Do Not Have Crew Operations Within the Rack Volume** – The Integrated rack (including any supporting adjunct active portable equipment operated outside the integrated rack that is within or interfacing with the crew habitable volume) Intermittent Noise Source (See Glossary of Terms) shall not exceed the Total Rack A-weighted SPL Limits during the Maximum Rack Noise Duration as specified in Table 3.12.3.3.2–1 when the equipment is operating in the loudest expected configuration and mode of operation that can occur on orbit under any planned operations.

Note: These acoustic requirements do not apply during failure or maintenance operations.

TABLE 3.12.3.3.2–1 INTERMITTENT NOISE LIMITS

Rack Noise Limits Measured at 0.6 meters distance from the test article	
Maximum Rack Noise Duration	**Total Rack A-weighted SPL (dBA)**
8 Hours	49
7 Hours	50
6 Hours	51
5 Hours	52
4.5 Hours	53
4 Hours	54
3.5 Hours	55
3 Hours	57
2.5 Hours	58
2 Hours	60
1.5 Hours	62
1 Hour	65
30 Minutes	69
15 Minutes	72
5 Minutes	76
2 Minutes	78
1 Minute	79
Not Allowed	80

The Rack Noise Duration is the total time that the rack produces intermittent noise above the NC–40 limit during a 24 hour time period. This duration is the governing factor in determining the allowable Intermittent Noise Limits. Regardless of the number of separate sources and varying durations within a rack, this cumulative duration shall be used to determine the A-weighted SPL limit in column B.

For example, if a rack produces 65 dBA for 30 minutes in a start-up and warm-up mode and then settles down to 60 dBA for a one hour period of normal data acquisition, the duration is 1.5 hours. To meet the requirement, the noise can be no greater than 60 dBA, and in this case, the rack would not meet the requirement, even though two separate payloads, one that operated at 65 dBA for 30 minutes and another that operated at 60 dBA for one hour, would be acceptable (see Figure 3.12.3.3.2–1).

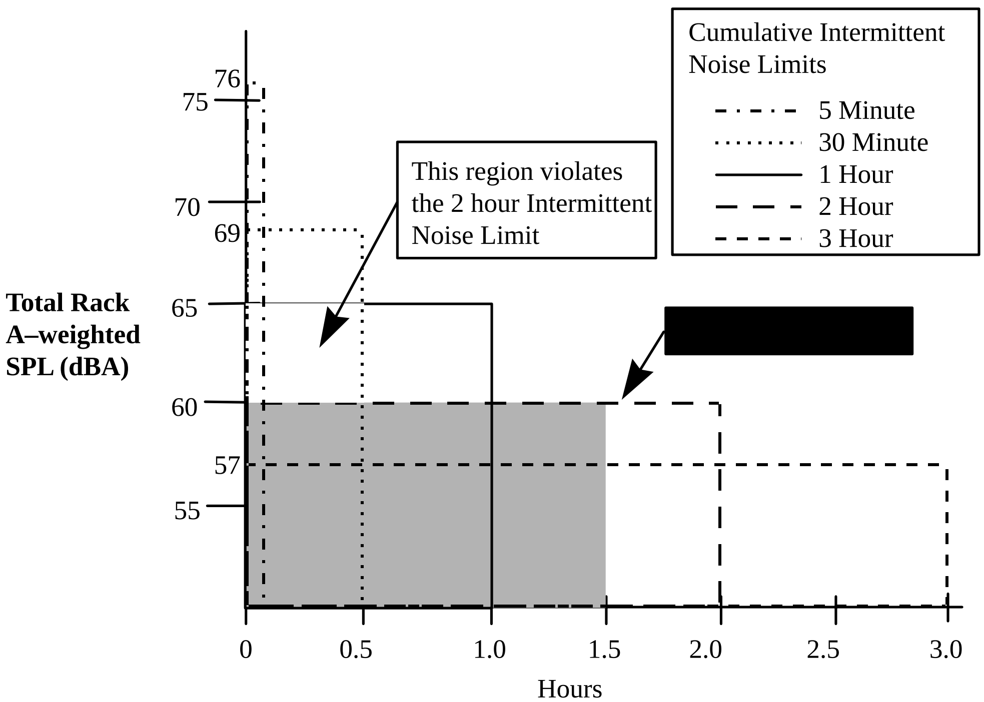


FIGURE 3.12.3.3.2–1 INTERMITTENT NOISE LIMITS

B. **Integrated Racks That Have Crew Operations Within the Rack Volume** – In addition to the requirements of paragraph 3.12.3.3.2 (A), the noise level at expected head positions in an ISPR occupied by a crewmember for nominal payload operations, shall not exceed the Total Rack A–Weighted SPL Limits during the maximum noise duration as specified in Table 3.12.3.3.2–2. The maximum noise duration limit is determined based on noise produced from both equipment operated inside the rack volume, as well as that coming from adjoining racks while being operated in their loudest expected configuration and mode of operation.

TABLE 3.12.3.3.2–2 INTERNAL RACK VOLUME INTERMITTENT NOISE LIMITS

Noise Limits at the Nominal Location of a Crew Members Head During Payload Operations	
A	**B**
Maximum Rack Noise Duration Per 24 Hour Period	**Total Rack A-weighted SPL (dBA) Limits**
8 Hours	58
7 Hours	59
6 Hours	60
5 Hours	62
4 Hours	63
3 Hours	65
2 Hours	66
1 Hour	68
30 Minutes	69
15 Minutes	71
5 Minutes	72
2 Minutes	73
1 Minute	74
Not Allowed	75

The Rack Noise Duration is the total time that the rack produces intermittent noise above the continuous noise limit during a 24 hour time period. This duration is the governing factor in determining the allowable Intermittent Noise Limit. Regardless of the number of separate noise sources and varying durations within a rack, this cumulative duration shall be used to determine the A-weighted SPL limit in column B.

3.12.3.4 LIGHTING DESIGN

The general illumination of the space station in the aisle will be a minimum of 108 lux (10 foot candles) of white light. This illumination will be sufficient for ordinary payload operations performed in the aisle (e.g., examining dials or panels, reading procedures, transcription, tabulation, etc.).

Payloads will meet the following requirements:

A. Payload work surface specularity shall not exceed 20 percent. Paints listed in Table 3.12.3.4–1 meet this requirement.

B. Lighting levels for tasks to be performed at payload worksites shall be provided, as defined in Table 3.12.3.4–2.

C. Light sources shall be dimmable.

D. Lighting in gloveboxes, excluding spot illumination, shall not exceed a brightness ratio of 3:1.

E. Medium payload operational tasks shall utilize the ISS Portable Utility Light (PUL) specified in JSC 27199.

TABLE 3.12.3.4–1 SURFACE INTERIOR COLORS AND PAINTS

HARDWARE DESCRIPTION	COLOR	FINISH	PAINT SPECIFICATION PER FED–STD–595
Equipment Rack Utility Panel Recess	White	Semigloss	27925
Equipment Rack Utility Panel Text Characters	Black	Lusterless	37038
ISPR Utility Panel Recess	White	Semigloss	27925
ISPR Utility Panel Recess Text Characters	Black	Lusterless	37038
Functional Unit Utility Panel Recess (as applicable)	White	Semigloss	27925
Functional Unit Utility Panel Recess Text Characters	Black	Lusterless	37038
Rack Front Aisle Extensions	Off-White	Semigloss	27722
Overhead Rack Face Plates	Off-White	Semigloss	27722
Port Rack Face Plates	Off-White	Semigloss	27722
Starboard Rack Face Plates	Off-White	Semigloss	27722
Deck Rack Face Plates	Off-White	Semigloss	27722
Overhead Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Port Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Starboard Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Deck Rack Utility Panel Closeouts	Off-White	Semigloss	27722
Stowage Trays	Off-White	Semigloss	27722
Stowage Tray Handle Straps (any location)	Natural/Off White Material	Semigloss	none
Common Seat Track	Nickel Plate	Semigloss	none
Glovebox (Aluminum or Plastic)	Medium Gray	Gloss	16329 or 16373
Glovebox (Aluminum)	White	Gloss	17925
Glovebox (Aluminum or Plastic)	Off-White	Gloss	17722
Glovebox (Aluminum)	Tan	Gloss	10475
EXPRESS Program Rack Utility Panels	Off–White	Gloss	17875

TABLE 3.12.3.4–2 PAYLOAD REQUIRED ILLUMINATION LEVELS

Type of Task	Required Lux (Foot-Candles)*
Medium payload operations (not performed in the aisle) (e.g., payload change-out and maintenance)	325 (30)
Fine payload operations (e.g., instrument repair)	1075 (100)
Medium glovebox operations (e.g., general operations, experiment set-up)	975 (90)
Fine glovebox operations (e.g., detailed operations, protein crystal growth, surgery/dissection, spot illumination)	1450 (135)

* As measured at the task site

3.12.4 STRUCTURAL/MECHANICAL INTERFACES

3.12.4.1 DELETED

3.12.4.2 PAYLOAD HARDWARE MOUNTING

3.12.4.2.1 EQUIPMENT MOUNTING

Equipment items used during nominal operations and planned maintenance shall be designed, labeled, or marked to protect against improper installation.

3.12.4.2.2 DRAWERS AND HINGED PANELS

Payload ORU's which are pulled out of their installed positions for routine checkout shall be mounted on equipment drawers or on hinged panels. Such drawers or hinged panels shall remain in the "open" position without being supported by hand.

3.12.4.2.3 DELETED

3.12.4.2.4 DELETED

3.12.4.2.5 ALIGNMENT

Payload hardware having blind mate connectors shall provide guide pins or their equivalent to assist in alignment of hardware during installation.

3.12.4.2.6 SLIDE-OUT STOPS

Limit stops shall be provided on slide or pivot mounted sub-rack hardware which is required to be pulled out of its installed positions.

3.12.4.2.7 PUSH-PULL FORCE

Payload hardware mounted into a capture-type receptacle that requires a push-pull action shall require a force less than 156 N (35 lbf) to install or remove.

3.12.4.2.8 ACCESS

Access to inspect or replace a hardware item (e.g., an ORU) which is planned to be accessed on a daily or weekly basis shall not require removal of another hardware item or more than one access cover.

3.12.4.2.8.1 COVERS

Where physical access is required, one of the following practices shall be followed, with the order of preference given.

A. Provide a sliding or hinged cap or door where debris, moisture, or other foreign materials might otherwise create a problem.

B. Provide a quick-opening cover plate if a cap will not meet stress requirements.

3.12.4.2.8.2 SELF-SUPPORTING COVERS

All access covers that are not completely removable shall be self-supporting in the open position.

3.12.4.2.8.3 DELETED

3.12.4.2.8.4 UNIQUE TOOLS

Payload provided unique tools shall meet the requirements of SSP 50005, paragraph 11.2.3.

3.12.4.3 CONNECTORS

3.12.4.3.1 ONE-HANDED OPERATION

All ORU connectors, whether operated by hand or tool, shall be designed and placed so they can be mated/demated using either hand.

3.12.4.3.2 ACCESSIBILITY

A.

(1) Nominal Operations – It shall be possible to mate/demate individual connectors without having to remove or mate/demate other connectors.

(2) Maintenance Operations – It shall be possible to mate/demate individual connectors without having to remove or mate/demate connectors on other ORUs or payloads.

B. Electrical connectors and cable installations shall permit disconnection and reconnection without damage to wiring connectors.

3.12.4.3.3 EASE OF DISCONNECT

A. Electrical connectors which are mated/demated during nominal operations shall require no more than two turns to disconnect.

B. Electrical connectors which are mated/demated during ORU replacement operations only, shall require no more than six turns to disconnect.

3.12.4.3.4 INDICATION OF PRESSURE/FLOW

Payload liquid or gas lines not equipped with quick disconnect connectors which are designed to be connected/disconnected under pressure shall be fitted with pressure/flow indicators.

3.12.4.3.5 SELF LOCKING

Payload electrical connectors shall provide a self-locking feature.

3.12.4.3.6 CONNECTOR ARRANGEMENT

A. Space between connectors and adjacent obstructions shall be a minimum of 25mm (1 inch) for IVA access

B. Connectors in a single row or staggered rows which are removed sequentially by the crew (IVA) shall provide 25mm (1inch) of clearance from other connectors and/or adjacent obstructions for 270 degrees of sweep around each connector beginning at the start of its removal/replacement sequence.

3.12.4.3.7 ARC CONTAINMENT

Electrical connector plugs shall be designed to confine/isolate the mate/demate electrical arcs or sparks.

3.12.4.3.8 CONNECTOR PROTECTION

Protection shall be provided for all demated connectors against physical damage and contamination.

3.12.4.3.9 CONNECTOR SHAPE

Integrated rack and sub-rack connectors shall use different connector shapes, sizes or keying to prevent mating connectors when lines differ in content.

3.12.4.3.10 FLUID AND GAS LINE CONNECTORS

Fluid and gas connectors that are mated and demated on-orbit shall be located and configured so that they can be fully inspected for leakage.

3.12.4.3.11 ALIGNMENT MARKS OR GUIDE PINS

Mating parts shall have alignment marks in a visible location during mating or guide pins (or their equivalent).

3.12.4.3.12 CODING

A. Both halves of mating connectors shall display a code or identifier which is unique to that connection

B. The labels or codes on connectors shall be located so they are visible when connected or disconnected.

3.12.4.3.13 PIN IDENTIFICATION

Each pin shall be uniquely identifiable in each electrical plug and each electrical receptacle. At least every 10th pin must be labeled.

3.12.4.3.14 ORIENTATION

Grouped plugs and receptacles shall be oriented so that the aligning pins or equivalent devices are in the same relative position.

3.12.4.3.15 HOSE/CABLE RESTRAINTS

A. The integrated rack shall provide a means to restrain the loose ends of hoses and cables.

B. Conductors, bundles, or cables shall be secured by means of clamps unless they are contained in wiring ducts or cable retractors.

C. Cables should be bundled if multiple cables are running in the same direction and the bundling does not cause EMI.

D. Loose cables (longer than 0.33 meters (1 foot) shall be restrained as follows:

Length (m)	Restraint Pattern (% of length) tolerances +/– 10%)
0.33–1.00	50
1.00–2.00	33,67
2.00–3.00	20, 40, 60, 80
>3.00	at least each 0.5 meters

3.12.4.4 FASTENERS

3.12.4.4.1 NON-THREADED FASTENERS STATUS INDICATION

An indication of correct engagement (hooking, latch fastening, or proper positioning of interfacing parts) of non-threaded fasteners shall be provided.

3.12.4.4.2 MOUNTING BOLT/FASTENER SPACING

Clearance around fasteners to permit fastener hand threading (if necessary) shall be a minimum of 0.5 inches for the entire circumference of the bolt head and and a minimum of 1.5 inches over 180 degrees of the bolt head and provide the tool handle sweep as seen in Figure 3.12.4.4.2–1. Excepted are NSTS standard middeck lockers or payload–provided hardware with the static envelope dimensions (cross–section) as specified in Figures 3.4.2.1–1, 3.4.2.2–1 and 3.4.2.3–1 of NSTS–21000–IDD–MDK and other similar captive fastener arrangements.

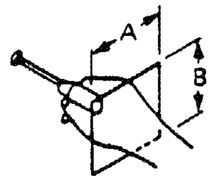
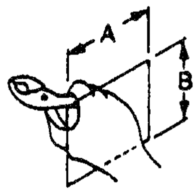
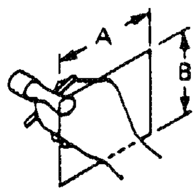
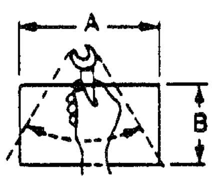
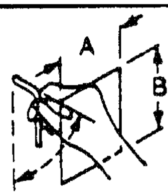
Opening dimensions		Task
	A 117 mm (4.6 in) B 107 mm (4.2 in)	Using common screw-driver with freedom to turn hand through 180 °
	A 133 mm (5.2 in) B 115 mm (4.5 in)	Using pliers and similar tools
	A 155 mm (6.1 in) B 135 mm (5.3 in)	Using T-handle wrench with freedom to turn wrench through 180 °
	A 203 mm (8.0 in) B 135 mm (5.3 in)	Using open-end wrench with freedom to turn wrench through 62 °
	A 122 mm (4.8 in) B 155 mm (6.1 in)	Using Allen-type wrench with freedom to turn wrench through 62 °

FIGURE 3.12.4.4.2–1 MINIMAL CLEARANCE FOR TOOL–OPERATED FASTENERS

3.12.4.4.3 DELETED

3.12.4.4.4 MULTIPLE FASTENERS

When several fasteners are used on one item they shall be of identical type.

3.12.4.4.5 CAPTIVE FASTENERS

All fasteners planned to be installed and/or removed on-orbit shall be captive when disengaged.

3.12.4.4.6 QUICK RELEASE FASTENERS

A. Quick release fasteners shall require a maximum of one complete turn to operate (quarter – turn fasteners are preferred).

B. Quick release fasteners shall be positive locking in open and closed positions.

3.12.4.4.7 THREADED FASTENERS

Only right handed threads shall be used.

3.12.4.4.8 OVER CENTER LATCHES

A. Nonself-latching – Over center latches shall include a provision to prevent undesired latch element realignment, interface, or reengagement.

B. Latch lock – Latch catches shall have locking features.

C. Latch handles – If the latch has a handle, the latch handle and latch release shall be operable by one hand.

3.12.4.4.9 WINGHEAD FASTENERS

Winghead fasteners shall fold down and be retained flush with surfaces.

3.12.4.4.10 DELETED

3.12.4.4.11 FASTENER HEAD TYPE

A. Hex type external or internal grip or combination head fasteners shall be used where on-orbit crew actuation is planned, e.g., ORU replacement.

B. If a smooth surface is required, flush or oval head internal hex grip fasteners shall be used for fastening.

C. Slotted fasteners shall not be used to carry launch loads for hard-mounted equipment. Slotted fasteners are allowed in non-structural applications (e.g., computer data connectors, stowed commercial equipment).

Note: Phillips or Torque-Set fasteners may be used where fastener installation is permanent relative to planned on-orbit operations or maintenance, or where tool-fastener interface failure can be corrected by replacement of the unit containing the affected fastener with a spare unit.

3.12.4.4.12 ONE-HANDED ACTUATION

Fasteners planned to be removed or installed on-orbit shall be designed and placed so they can be mated/demated using either hand.

3.12.4.4.13 DELETED

3.12.4.4.14 ACCESS HOLES

Covers or shields through which mounting fasteners must pass for attachment to the basic chassis of the unit shall have holes for passage of the fastener without precise alignment (and hand or necessary tool if either is required to replace).

3.12.5 CONTROLS AND DISPLAYS

3.12.5.1 CONTROLS SPACING DESIGN REQUIREMENTS

All spacing between controls and adjacent obstructions shall meet the minimum requirements as shown in Figure 3.12.5.1–1, Control Spacing Requirements for Ungloved Operation.

3.12.5.2 ACCIDENTAL ACTUATION

Requirements for reducing accidental actuation of controls are defined as follows:

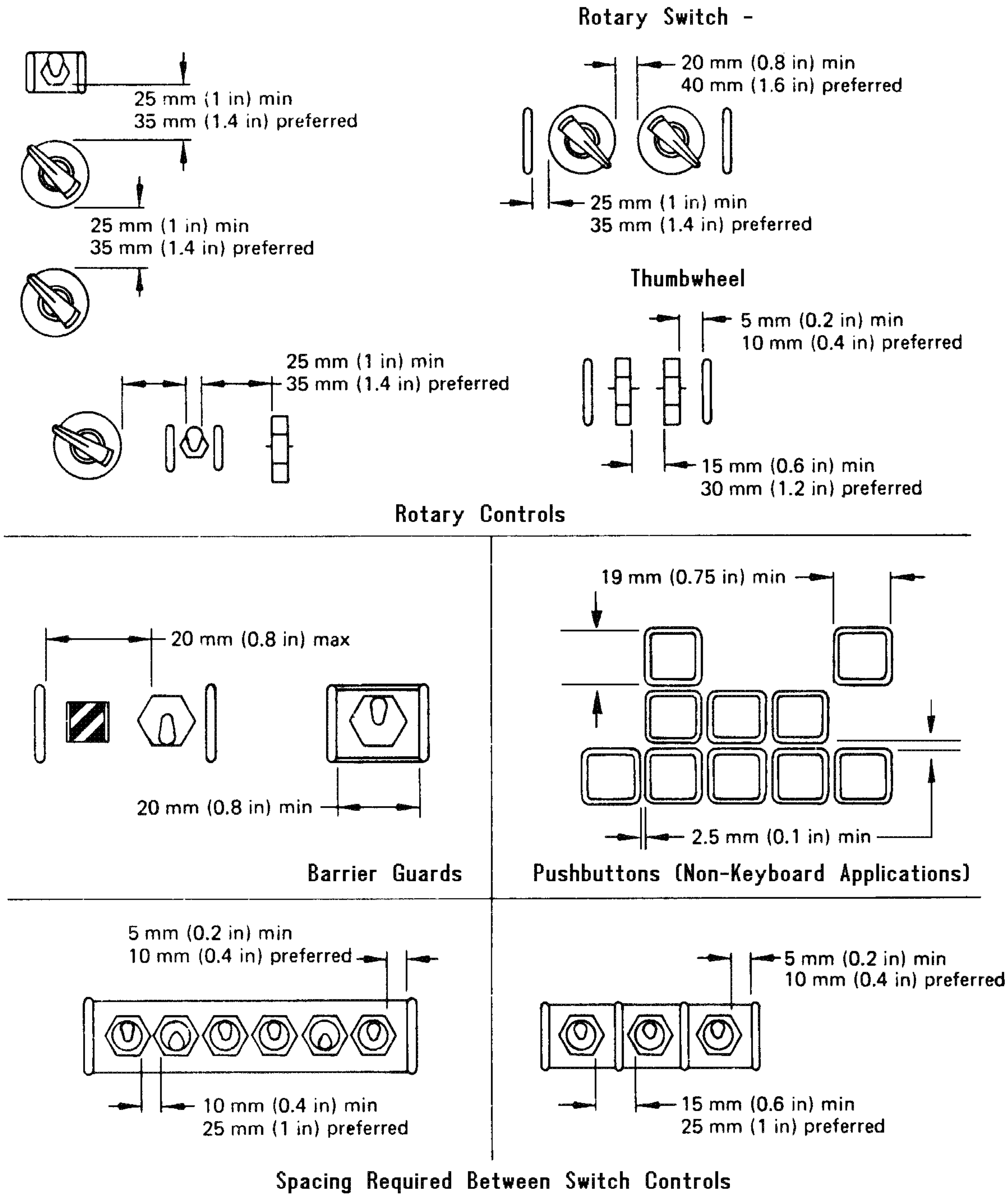


FIGURE 3.12.5.1–1 CONTROL SPACING REQUIREMENTS FOR UNGLOVED OPERATION

3.12.5.2.1 PROTECTIVE METHODS

Payloads shall provide protection against accidental control actuation using one or more of the protective methods listed in sub–paragraphs A through G below. Infrequently used controls (i.e. those used for calibration) should be separated from frequently used controls. Leverlock switches or switch covers are strongly recommended for switches related to mission success. Switch guards may not be sufficient to prevent accidental actuation.

Note: Displays and controls used only for maintenance and adjustments, which could disrupt normal operations if activated, should be protected during normal operations, e.g., by being located separately or guarded/covered.

A. Locate and orient the controls so that the operator is not likely to strike or move them accidentally in the normal sequence of control movements.

B. Recess, shield, or otherwise surround the controls by physical barriers. The control shall be entirely contained within the envelope described by the recess or barrier.

C. Cover or guard the controls. Safety or lock wire shall not be used.

D. Cover guards when open shall not cover or obscure the protected control or adjacent controls.

E. Provide the controls with interlocks so that extra movement (e.g., lifting switch out of a locked detent position) or the prior operation of a related or locking control is required.

F. Provide the controls with resistance (i.e., viscous or coulomb friction, spring-loading, or inertia) so that definite or sustained effort is required for actuation.

G. Provide the controls with a lock to prevent the control from passing through a position without delay when strict sequential actuation is necessary (i.e., the control moved only to the next position, then delayed).

3.12.5.2.2 NONINTERFERENCE

Payload provided protective devices shall not cover or obscure other displays or controls.

3.12.5.2.3 DEAD-MAN CONTROLS

Dead-man controls are covered under NSTS 1700.7, ISS Addendum paragraphs 200.4a and 303.2.

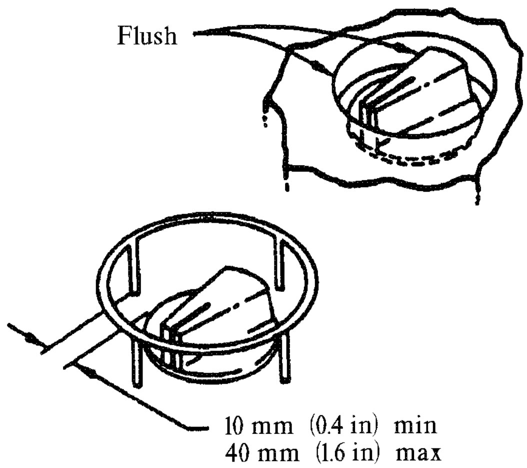


FIGURE 3.12.5.2.3–1 ROTARY SWITCH GUARD

3.12.5.2.4 BARRIER GUARDS

Barrier guard spacing shall adhere to the requirements for use with the toggle switches, rotary switches, and thumbwheels as shown in Figures 3.12.5.1–1, Control Spacing Requirements for Ungloved Operation and 3.12.5.2.3–1, Rotary Switch Guard.

3.12.5.2.5 RECESSED SWITCH PROTECTION

When a barrier guard is not used, rotary switches that control critical functions shall be recessed as shown in Figure 3.12.5.2.3–1, Rotary Switch Guard.

3.12.5.2.6 DELETED

3.12.5.2.7 POSITION INDICATION

When payload switch protective covers are used, control position shall be evident without requiring cover removal.

3.12.5.2.8 HIDDEN CONTROLS

Controls that cannot be directly viewed will be avoided. If present, hidden controls shall be guarded to protect against inadvertent actuation.

3.12.5.2.9 HAND CONTROLLERS

Hand controllers, excluding trackballs and mice, shall have a separate on/off control to prevent inadvertent actuation when the controller is not in use.

3.12.5.3 VALVE CONTROLS

Requirements for design of payload valve controls are defined as follows:

A. Low-Torque Valves – Valves requiring 1 N–m (10 in–lb) or less for operation are classified as "low-torque" valves and shall be provided with a "central pivot" type handle, 5.5 cm (2.25 in) or less in diameter. (see 3.12.5.3 D)

B. Intermediate-Torque Valves – Valves requiring between 1 and 2 N–m (10 and 20 in–lb) for operation are classified as "intermediate torque" valves and shall be provided with a "central pivot" type handle, 5.5 cm (2.25 in) or greater in diameter, or a "lever (end pivot type" handle, 7.5 cm (3 in) or greater in length.

C. High-Torque Valves – Valves requiring 2 N–m (20 in–lb) or more for operation are classified as "high-torque" valves and shall be provided "lever type" handles greater than 7.5 cm (3 in) or greater in length.

D. Handle Dimensions – Valve handles shall adhere to the clearances and dimensions illustrated in Figures 3.12.5.3–1, Valve Handle-Central Pivot Type and 3.12.5.3–2, Valve Handle-Lever Type.

E. Rotary Valve Controls – Rotary valve controls shall open the valve with a counter-clockwise motion.

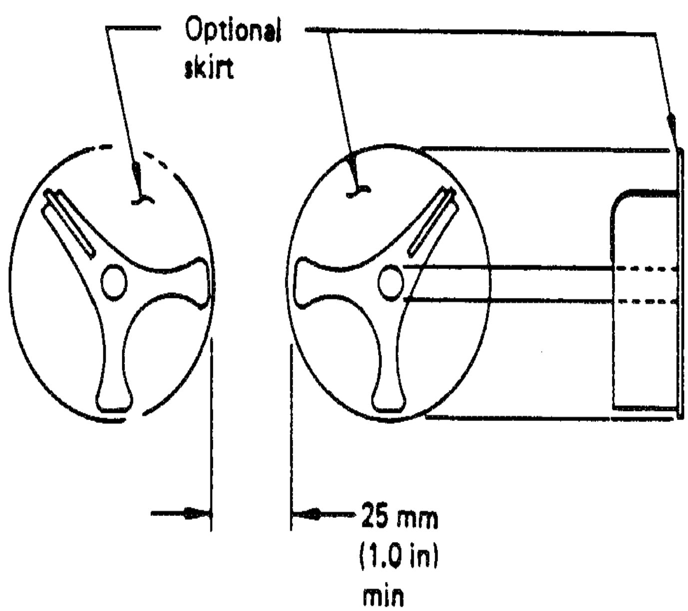


FIGURE 3.12.5.3–1 VALVE HANDLE - CENTRAL PIVOT TYPE

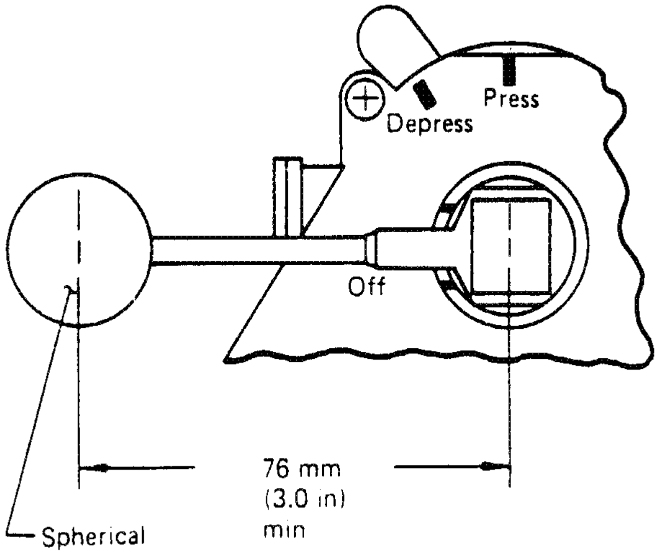


FIGURE 3.12.5.3–2 VALVE HANDLE – LEVER TYPE

3.12.5.4 TOGGLE SWITCHES

Dimensions for a standard toggle switch shall conform to the values presented in Figure 3.12.5.4–1, Toggle Switches.

3.12.6 RESTRAINTS AND MOBILITY AIDS

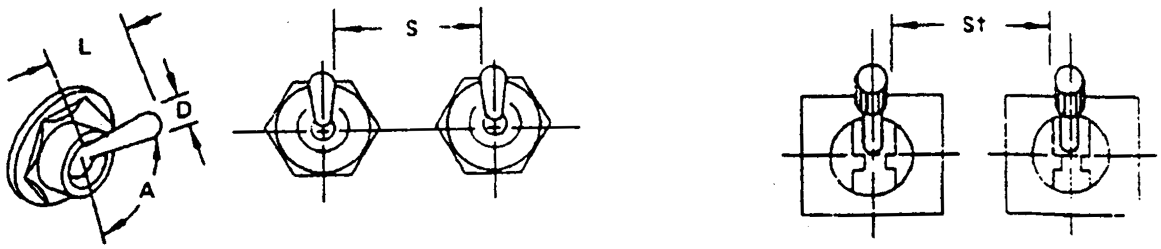
The integrated rack shall be designed such that all installation, operation, and maintenance can be performed using standard crew restraints, mobility aids, and interfaces as defined in SSP 30257:004.

3.12.6.1 STOWAGE DRAWER CONTENTS RESTRAINTS

A. Payload drawer/tray contents shall be restrained in such a way that the items do not float when the drawer/tray is opened or closed.

B. Payload drawer/tray contents shall be restrained in a way such that the items do not jam the drawer when the drawer is opened or closed.

C. Drawer/tray contents shall be restrained in such a way that the contents can be removed/replaced without using a tool.



	Dimensions		Resistance	
	L Arm length	D Control tip	Small switch	Large switch
Minimum	13 mm (1/2 in)	3mm (1/8 in)	2.8 N (10 oz)	2.8 N (10 oz)
Maximum	50 mm (2 in)	25 mm (1 in)	4.5 N (16 oz)	11 N (40 oz)

	Displacement between positions A	
	2 position	3 position
Minimum	30°	17°
Maximum	80°	40°
Desired		25°

	Separation S			
	Single finger operation	†	Single finger sequential operation	Simultaneous operation by different fingers
Minimum	19 mm (3/4 in)	25 mm (1 in)	13 mm (1/2 in)	16 mm (5/8 in)
Optimum	50 mm (2 in)	50 mm (2 in)	25 mm (1 in)	19 mm (3/4 in)

† Using a lever lock toggle switch

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Reference: 2, page 93

FIGURE 3.12.5.4–1 TOGGLE SWITCHES

3.12.6.2 STOWAGE AND EQUIPMENT DRAWERS/TRAYS

A. All latches, handles, and operating mechanisms shall be designed to be latched/unlatched and opened/closed with one hand by the 95th percentile American male to the 5th percentile female.

B. The design of latches shall be such that their status (locked/unlocked) can be determined through visual inspection.

3.12.6.3 CAPTIVE PARTS

Payloads and payload equipment shall be designed in such a manner to ensure that all unrestrained parts (e.g., locking pins, knobs, handles, lens covers, access plates, or similar devices) that may be temporarily removed on orbit will be tethered or otherwise held captive.

3.12.6.4 HANDLE AND GRASP AREA DESIGN REQUIREMENTS

3.12.6.4.1 HANDLES AND RESTRAINTS

All removable or portable items that are larger than 1 ft3 shall be provided with handles or other suitable means of grasping, tethering, carrying and restraining. Hand size dimensions are provided in Table 3.12.6.4.1–1. Figure 3.12.6.4.1–1 shows where the measurements are taken for hand size dimensions.

TABLE 3.12.6.4.1–1 HAND SIZE DIMENSIONS

	5^{TH} Percentile Female Inches (mm)	95^{TH} Percentile Male Inches (mm)
Length (420)	6.2 (158)	8.1 (206)
Breadth (411)	2.7 (69)	3.8 (96)
Circumference (416)	6.5 (166)	9.2 (234)

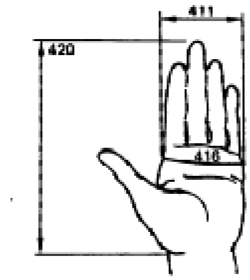


FIGURE 3.12.6.4.1–1 HAND SIZE DIMENSIONS

Number	Measurement
420	Hand Length
411	Hand Breadth
416	Hand Circumference

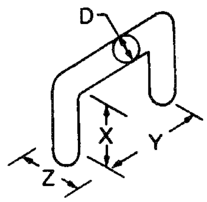
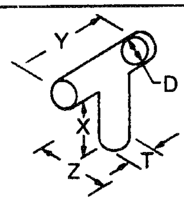
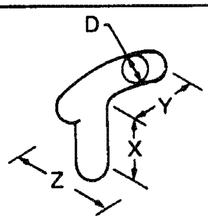
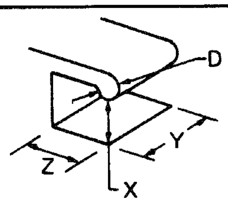
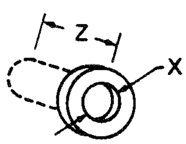
3.12.6.4.2 DELETED

3.12.6.4.3 HANDLE LOCATION/FRONT ACCESS

Handles and grasp areas shall be placed on the accessible surface of a payload item consistent with the removal direction.

3.12.6.4.4 HANDLE DIMENSIONS

IVA handles for movable or portable units shall be designed in accordance with the minimum applicable dimensions in Figure 3.12.6.4.4–1.

Illustration	Type of handle	Dimensions in mm (in inches) (Bare hand) X	Y	Z
	Two-finger bar	32 (1–1/4)	65 (2–1/2)	75 (3)
	One-hand bar	48 (1–7/8)	111 (4–3/8)	75 (3)
	Two-hand bar	48 (1–7/8)	215 (8–1/2)	75 (3)
	T-bar	38 (1–1/2)	100 (4)	75 (3)
	J-bar	50 (2)	100 (4)	75 (3)
	Two-finger recess	32 (1–1/4)	65 (2–1/2)	75 (3)
	One-hand recess	50 (2)	110 (4–1/4)	90 (3–1/2)
	Finger-tip recess	19 (3/4)	–	13 (1/2)
	One-finger recess	32 (1–1/4)	–	50 (2)

Curvature of handle or edge (DOES NOT PRECLUDE USE OF OVAL HANDLES)	Weight of Item	Minimum diameter	
	Up to 6.8 kg (up to 15 lbs)	D = 6 mm (1/4 in)	Gripping efficiency is best if finger can curl around handle or edge to any angle of 2/3 π rad (120°) or more
	6.8 to 9.0 kg (15 to 20 lbs)	D = 13 mm (1/2 in)	
	9.0 to 18 kg (20 to 40 lbs)	D = 19 mm (3/4 in)	
	Over 18 kg (over 40 lbs)	D = 25 mm (1 in)	
	T-bar post	T = 13 mm (1/2 in)	

FIGURE 3.12.6.4.4–1 MINIMUM IVA HANDLE DIMENSIONS FOR IVA APPLICATIONS

3.12.6.4.5 NON-FIXED HANDLES DESIGN REQUIREMENTS

Hinged, foldout, or attachable (i.e., non-fixed) handles will comply with the following:

A. Nonfixed handles shall have a stop position for holding the handle perpendicular to the surface on which it is mounted.

B. Nonfixed handles shall be capable of being placed in the use position by one hand and shall be capable of being removed or stowed with one hand.

C. Attachable/removable handles shall incorporate tactile and/or visual indication of locked/unlocked status.

3.12.7 IDENTIFICATION LABELING

Integrated racks, all (installed in the rack or separately) sub–rack elements, loose equipment, stowage trays, consumables, ORUs, crew accessible connectors and cables, switches, indicators, and controls shall be labeled. Labels are markings of any form (including IMS bar cards) such as decals and placards, which can be adhered, “silk screened”, engraved, or otherwise applied directly onto the hardware. Appendix C provides instructions for label and decal design and approval.

3.12.8 COLOR

Payloads shall select interior colors in accordance with the requirements in Table 3.12.3.4–1.

3.12.9 CREW SAFETY

3.12.9.1 ELECTRICAL HAZARDS

3.12.9.1.1 MISMATCHED

The design of electrical connectors shall make it impossible to inadvertently reverse a connection or mate the wrong connectors if a hazardous condition can be created. Payload and on-orbit support equipment, wire harnesses, and connectors shall be designed such that no blind connections or disconnections must be made during payload installation, operation, removal, or maintenance on orbit unless the design includes scoop proof connectors or other protective features (NSTS 1700.7, ISS Addendum, paragraph 221).

For payload equipment, for which mismating or cross-connection may damage ISS-provided equipment, plugs, and receptacles (connectors), shall be selected and applied such that they cannot be mismatched or cross-connected in the intended system as well as adjacent systems.

Although identification markings or labels are required, the use of identification alone is not sufficient to preclude mismating.

For all other payload connections, combinations of identification, keying and clocking, and equipment test and checkout procedures shall be employed at the payload's discretion to minimize equipment risk while maximizing on-orbit operability.

3.12.9.1.2 DELETED

3.12.9.1.3 DELETED

3.12.9.1.4 OVERLOAD PROTECTION

3.12.9.1.4.1 DEVICE ACCESSIBILITY

An overload protective device shall not be accessible without opening a door or cover, except that an operating handle or operating button of a circuit breaker, the cap of an extractor-type fuse holder, and similar parts may project outside the enclosure.

3.12.9.1.4.2 EXTRACTOR –TYPE FUSE HOLDER

The design of the extractor-type fuse holder shall be such that the fuse is extracted when the cap is removed.

3.12.9.1.4.3 OVERLOAD PROTECTION LOCATION

Overload protection (fuses and circuit breakers) intended to be manually replaced or physically reset on-orbit shall be located where they can be seen and replaced or reset without removing other components.

3.12.9.1.4.4 OVERLOAD PROTECTION IDENTIFICATION

Each overload protector (fuse or circuit breaker) intended to be manually replaced or physically reset on-orbit shall be readily identified or keyed for its proper value.

3.12.9.1.4.5 AUTOMATIC RESTART PROTECTION

Controls shall be employed that prevent automatic restarting after an overload-initiated shutdown.

3.12.9.1.5 DELETED

3.12.9.1.5.1 DELETED

3.12.9.2 SHARP EDGES AND CORNERS PROTECTION

Payload design within a pressurized module shall protect crewmembers from sharp edges and corners during all crew operations in accordance with NSTS 1700.7, ISS Addendum, paragraph 222.1.

3.12.9.3 HOLES

Holes that are round or slotted in the range of 10.0 to 25.0 mm (0.4 to 1.0 in.) shall be covered.

3.12.9.4 LATCHES

Latches that pivot, retract, or flex so that a gap of less than 35 mm (1.4) exists shall be designed to prevent entrapment of a crewmember’s appendage.

3.12.9.5 SCREWS AND BOLTS

Threaded ends of screws and bolts accessible by the crew and extending more than 3.0 mm (0.12 in.) shall be capped to protect against sharp threads.

3.12.9.6 SECURING PINS

Securing pins shall be designed to prevent their inadvertently backing out above the handhold surface.

3.12.9.7 LEVERS, CRANKS, HOOKS, AND CONTROLS

Levers, cranks, hooks, and controls shall not be located where they can pinch, snag, or cut the crewmembers or their clothing.

3.12.9.8 BURRS

Exposed surfaces shall be free of burrs.

3.12.9.9 LOCKING WIRES

A. Safety wires shall not be used on fasteners which must be unfastened for on-orbit removal or replacement.

B. All fracture-critical fasteners as defined in SSP 52005 (paragraph 5.6, Fastener Requirements, and Appendix B, Glossary of Terms), which must be unfastened for on-orbit removal or replacement shall be safety cabled or cotter pinned.

3.12.9.10 AUDIO DEVICES (DISPLAYS)

A. The design of audio devices (displays) and circuits shall protect against false alarms.

B. Deleted.

C. All audio device (displays) shall be equipped with circuit test devices or other means of operability testing.

D. An interlocked, manual disable shall be provided if there is any failure mode which can result in a sustained activation of an audio device (display).

3.12.9.11 DELETED

3.12.9.12 EGRESS

All payload egress requirements shall be in accordance with 1700.7, ISS Addendum, paragraph 205.

3.12.9.13 LASERS

Note: Payloads requiring the use of lasers must meet the safety requirements defined in NSTS/ISS 1700.7B Addendum, paragraph 212, Lasers. Successful implementation and verification will be accomplished through the payload safety review process.

3.12.9.14 OPTICAL EQUIPMENT AND INSTRUMENTS

Note: Payloads requiring the use of optical equipment must meet the safety requirements defined in NSTS/ISS 1700.7B Addendum, paragraph 212.4, Optical Equipment. Successful implementation and verification will be accomplished through the payload safety review process.

3.12.10 PAYLOAD IN-FLIGHT MAINTENANCE

Payloads shall be designed to be maintainable using Space Station provided on-board tools. A list of available tools on-orbit are defined in the Payloads Accommodations Handbook.

4.0 VERIFICATION

This section provides the complete set of verification requirements necessary to ensure compliance with the interface and design requirements contained in section 3. The verification requirements in this section shall be complied with by all U.S. provided integrated racks and all International Partner provided integrated racks that operate in the U.S. Laboratory module or Centrifuge Accommodations Module (CAM). These requirements, combined with the formats and guidelines contained in the Generic Payload Verification Plan form the basis for the development of a unique Payload Verification Plan (PVP).

4.1 RESPONSIBILITIES

The Rack Integrator is responsible for development and implementation of a unique Payload Verification Plan for the integrated rack. The Rack Integrator is also responsible for allocating and tracing the integrated rack level verification requirements into sub-rack payload or equipment verification plans. The Rack Integrator is also responsible for providing certification of compliance for all applicable verification requirements in this document. Applicable requirements are identified in the Traceability Matrices in the unique Payload Hardware and Software ICDs, SSP 57001 and SSP 57002 respectively. The Rack Integrator is also responsible for providing all data/test results required in this section. The ISS is responsible for review and approval of the Unique ICDs and PVPs.

4.2 VERIFICATION METHODS

The following verification methods are specified in this section:

A. INSPECTION – Inspection is a physical measurement or visual evaluation of equipment and associated documentation. Inspection is used to verify construction features, drawing compliance, workmanship, and physical condition.

B. ANALYSIS – Analysis is the technical evaluation process of using techniques and tools such as mathematical models and computer simulation, historical/design/test data, and other quantitative assessments to calculate characteristics and verify specification compliance. Analysis is used to verify requirements compliance where established techniques are adequate to yield confidence or where testing is impractical.

C. DEMONSTRATION – Demonstration is the qualitative determination of compliance with requirements by observation during actual operation or simulation under preplanned conditions and guidelines.

D. TEST – Test is actual operation of equipment, normally instrumented, under simulated or flight equivalent conditions or the subjection of parts or equipment to specified environments to measure and record responses in a quantitative manner.

4.3 INTERFACE VERIFICATION METHODS

4.3.1 STRUCTURAL/MECHANICAL AND MICROGRAVITY AND STOWAGE INTERFACE REQUIREMENTS

4.3.1.1 STRUCTURAL/MECHANICAL

NVR

4.3.1.1.1 GSE INTERFACES

A. Interface compatibility to KSC GSE shall be verified by inspection of the integrated rack design drawings. Verification shall be considered successful when inspection of the drawing shows the interface is compatible with the drawings in SSP 41017 and the facility payload hardware is outside of the RID Keep–out zones or can be removed during rack installation. The NASA provided 683–50243–4 ISPR structure is assumed to meet these interfaces, provided that the integrated rack hardware does not exceed the static envelope or RID Keep–out envelope (reference SSP 41017, Part 1, Figures 3.2.1.1.2–1 and 3.2.1.1.2–2).

B. Integrated rack interfaces with the RSC shall be verified by a fit check demonstration. The demonstration shall be considered successful when it is shown that the rack can be successfully connected to the RSC. The NASA provided 683–50243–4 ISPR structure is assumed to meet these interfaces, provided that the integrated rack hardware does not exceed the static envelope requirement.

C. Rack compatibility with the RHA shall be verified by a fit check demonstration. The demonstration shall be considered successful when it is shown that the rack can be successfully connected to the RHA. The NASA provided 683–50243–4 ISPR structure is assumed to meet these interfaces, provided that the integrated rack hardware does not exceed the static envelope requirement.

D. Ground transportation acceleration limits shall be verified by test and analysis. The test and analysis shall be considered successful when the test provides a measurement of the maximum accelerations encountered during shipment in the 3 orthogonal rack axes and an analysis shows that these accelerations do not exceed 80% of the flight accelerations.

4.3.1.1.2 MPLM INTERFACES

A. Structural attach point compatibility shall be verified by inspection of the rack drawings and comparison with the table referenced in SSP 41017. The NASA provided 683–50243–4 ISPR structure is assumed to meet these interfaces.

B. An analysis shall be conducted which determines the maximum delta pressure from within to outside the integrated rack and shows that the integrated rack maintains positive margins of safety (delta pressure limited to 3.5 kPa (0.5 psi)). Verification shall be considered successful when the analysis shows that 3.5 kPa (0.5 psi) delta pressure is not exceeded. Verification may be by inspection of integrated rack design drawings for NASA provided 683–50243–4 ISPRs with intact and unblocked pressure relief valves).

C. Deleted.

D. Deleted.

E. An analysis shall be conducted using the referenced acceleration data and calculating the interface attach point loads via Finite Element Modeling (FEM). The analysis shall be considered successful when the FEM is approved by the ISS Program and it calculates attach point loads that do not exceed the MPLM allowable limits. A coupled loads analysis will be conducted by the ISS Program using the FEM provided to ensure that MPLM allowables are not exceeded when coupled loads are taken into account.

4.3.1.1.2.1 MPLM LATE / EARLY ACCESS REQUIREMENTS

The Late / Early Access cargo weight shall be verified by test. The verification shall be considered successful when the cargo (with GSE) weight does not exceed 250 lbs.

4.3.1.1.2.1.1 MPLM LATE ACCESS ENVELOPE (KSC)

A. The late access cargo dimension shall be verified by inspection. The verification shall be considered successful when it is shown by measurement that the cargo (with GSE) meets the late access hatch envelope identified in Figure 3.1.1.2.1.1–1.

B. The late access cargo dimension shall be verified by inspection. The verification shall be considered successful when it is shown by measurement that the cargo (with GSE) meets the late access hoist hook interface identified in Figure 3.1.1.2.1.1–2.

C. The late access cargo interface dimension shall be verified by inspection. The verification shall be considered successful when it is shown by measurement that the cargo (with GSE) meets the late access monorail hook hoist interface identified in Figure 3.1.1.2.1.1–3.

4.3.1.1.2.1.2 MPLM EARLY ACCESS ENVELOPES (KSC AND DFRC)

A. The early access cargo dimension shall be verified by inspection. The verification shall be considered successful when it is shown by measurement that the cargo (with GSE) meets the early access ODS envelope identified in Figure 3.1.1.2.1.2–1.

B. The early access cargo interface dimension shall be verified by inspection. The verification shall be considered successful when it is shown by measurement that the cargo (with GSE) meets the early access DEAP monorail interface identified in Figure 3.1.1.2.1.2–2.

4.3.1.1.3 LOADS REQUIREMENTS

A. An analysis shall be conducted which uses the referenced acceleration data and determines integrated rack structure loads via Finite Element Modeling (FEM). The analysis shall be considered successful when the FEM is approved by the ISS Program and the model determines integrated rack structure loads that maintain positive margins of safety, based upon the rack structure allowables identified in SSP 57007 Rack Integrator's Handbook.

B. An analysis shall be conducted to verify that integrated racks will maintain positive margins of safety during a transient or continuous load of 0.2 Gs.

C. The integrated rack design drawings shall be inspected to ensure that hardware is provided for umbilical restraint.

D. An analysis shall be performed to show that payload equipment exposed to the crew translation path maintains a positive margin of safety when exposed to the crew induced loads as defined in paragraph 3.1.1.3D. The verification shall be considered successful when the analysis shows positive margins exist for yield and ultimate loads for utility lines and for ultimate loads for all other exposed equipment.

E. An analysis shall be performed to show that the components mounted to U.S. ISPR posts shall maintains positive margins of safety for the MPLM launch random vibration environment as defined in paragraph 3.1.1.3. This analysis shall follow the guidelines provided in SSP 52005 paragraphs 4.1.2 and 4.1.5. The verification shall be considered successful when the analysis shows that components mounted to U.S. ISPR posts maintain positive margins of safety.

F. An analysis shall be performed to show that the components mounted to the ISPR rack maintain positive margins of safety after exposure to the design load factors for launch and landing environments as defined in paragraph 3.1.1.3. This analysis shall follow the guidelines provided in SSP 52005 paragraphs 4.1.2 and 4.1.3. The verification shall be considered successful when the coupled loads analysis shows that the components mounted to ISPR maintain positive margins of safety.

4.3.1.1.4 RACK REQUIREMENTS

A. The integrated rack weight requirement shall be verified by a demonstration involving measuring the weight of the integrated rack on the ground prior to launch and an analysis that accounts for attached GSE and any changes during on-orbit operations prior to return of the payload. Verification shall be considered successful when the weight is measured to an accuracy of 2.3 kg (5 lbs) (TBC) and is less than the specified maximum weight.

B. An analysis shall be conducted which determines the maximum delta pressure from within to outside the integrated rack and shows that the integrated rack maintains positive margins of safety (delta pressure limited to 3.5 kPa (0.5 psi)). Verification shall be considered successful when the analysis shows that 3.5 kPa (0.5 psi) delta pressure is not exceeded. Verification may be by inspection of integrated rack design drawings for NASA provided 683–50243–4 ISPRs with intact and unblocked pressure relief valves).

C. An analysis shall be conducted using the guidelines provided in SSP 52005 appendix C.1.2.2. The verification shall be considered successful when the analysis shows that integrated rack meets the frequency requirement specified.

D. Information – no verification necessary.

E. Verification shall be by inspection of the facility payload drawings to ensure that the keep–out zone is provided for rack pivots. The verification shall be considered successful when the inspection shows that the envelope is provided or analysis shows that the hardware can be moved out of the envelope and no other obstructions are present to prevent the rack from rotating.

F. An analysis shall be conducted to determine the clearance dimensions of the window hardware with the integrated rack hardware. The verification shall be considered successful when the analysis indicates a positive clearance.

G. Deleted.

H. Deleted.

I. An analysis shall be conducted using integrated rack and module data to evaluate the maximum rotation angle. The verification shall be considered successful when the rotation angle is calculated to be at least 80 degrees.

J. Deleted

K. An analysis shall be conducted which determines the maximum delta pressure from within to outside the integrated rack during PFE discharge and shows that the integrated rack maintains positive margins of safety (delta pressure limited to 3.5 kPa (0.5 psi) and rack equipment maintains positive margins of safety. Verification shall be considered successful when the analysis shows that the structures maintain positive margins.

L. Verification of rack positional and crew restraints at rotation angles shall be by analysis. The analysis shall show the use of restraints to maintain the rack in the position required for payload operations and maintenance. Verification shall be considered successful when the analysis shows that the ISS provided hardware can secure the rack in the required rotation positions.

M. Verification that the integrated rack does not have a pressure relief device located on the front of the rack except for pressure relief devices that are only used to minimize the pressure differential across an enclosed volume due to changes in the normal cabin operating pressure as defined in Figure 3.9.4–1 shall be by inspection. The inspection of the rack drawings shall show that no pressure relief devices except for pressure relief devices that are only used to minimize the pressure differential across an enclosed volume due to changes in the normal cabin operating pressure as defined in Figure 3.9.4–1 are located on the front of the rack. The verification shall be considered successful when the inspection determines that there are no pressure relief devices except for pressure relief devices that are only used to minimize the pressure differential across an enclosed volume due to changes in the normal cabin operating pressure as defined in Figure 3.9.4–1 are located on the front of the rack.

N. Verification that integrated rack comply with a keep–out zone shall be by analysis. The analysis shall include an inspection and evaluation of installation drawings/procedures. Verification shall be considered successful when the analysis verifies that the integrated rack provides a keep–out zone as specified in SSP 41017, Figure 3.2.1.1.2–1 Rack Static Envelope (Side View) and 3.2.1.1.2–2 Rack Static Envelope (Front View).

O. Verification of snubber keep–out envelope shall be by analysis. The analysis shall include an inspection and evaluation of installation drawings/procedures. The verification shall be considered successful when the analysis verifies that no payload hardware prohibits installation of these components on ARIS equipped racks.

P. The rack rotation shall be verified by analysis. The analysis shall be performed using lower–level component qualification data. The verification shall be considered successful when the pressurized volume racks that are designed to rotate, are shown able to rotate as specified.

Q. Verification that the integrated rack that has a pressure relief device on the front of the rack to minimize the pressure differential across an enclosed volume due to changes in the normal cabin operating pressure will not activate when exposed to the specified PFE discharge rate shall be by analysis. The verification shall be considered successful when the analysis shows that the integrated rack that has a pressure relief device on the front of the rack to minimize the pressure differential across an enclosed volume due to changes in the nominal cabin operating pressure will not activate when exposed to the specified PFE discharge rate.

R. Verification that seat tracks are installed on the integrated rack per SSP 41017, Part 2, Figure 3.3.5–1 shall be by inspection. The inspection shall be of the as–built hardware drawings to determine that seat tracks are installed per the defined requirements. The verification shall be considered successful if the inspection of the as–built drawings demonstrates that seat tracks are installed in the proscribed locations. Boeing ISPRs, part number 683–50243–4, meet this requirement.

S. Boeing ISPRs (683–50243–4), through use of the Seat Track Adapter Assembly, part number 683–60110, meet this requirement and no verification is required. For all other racks that will be installed in the JEM, the verification shall be by inspection or analysis and inspection.

The inspection shall be of the as–built hardware drawings to determine that seat track are installed in the locations defined in Figure 3.1.1.4–2. The verification shall be considered successful if the inspection demonstrates that 6 inch seat track are installed in the required locations.

The analysis shall identify the hardware, design accommodations, tools, and procedures necessary to install a STAA or equivalent in the locations defined in Figure 3.1.1.4–2 on–orbit. The inspection shall determine that the flight hardware provides the design accommodations and hardware identified in the analysis. The verification shall be considered successful if the analysis and inspection demonstrate that a STAA or equivalent can be installed in the required locations.

4.3.1.1.4.1 LAB WINDOW RACK LOCATION REQUIREMENTS

A. Verification that a protective cover is provided that prevents contact with the lab window surface shall be by analysis. An analysis shall be performed to determine whether or not the rack provided protective cover can withstand loads as specified in 3.1.1.3.D, cabinets and any other exposed equipment. Verification shall be considered successful when the analysis shows the cover can withstand the loads specified in 3.1.1.3.D, cabinets and any other exposed equipment.

B. Verification that integrated racks at the lab window location provide a keep–out zone as specified in SSP 57001, Figure 3.1.1.4–1 shall be by inspection. An inspection shall determine whether or not the integrated rack provides keep–out zones as specified in SSP 57001, Figure 3.1.1.4–1. Verification shall be considered successful when the inspection shows the integrated rack provides a keep–out zone as specified in SSP 57001, Figure 3.1.1.4–1.

C. Verification that the integrated rack at the lab window location provide a barrier between the Lab pressure wall and the integrated rack shall be by analysis. An analysis shall determine whether or not a barrier is provided by the integrated rack that would prevent airflow and debris from leaving/entering the integrated rack. Verification shall be considered successful when the analysis shows a barrier is provided that would prevent airflow and debris from entering/leaving the rack between the back of the rack and the pressure wall.

D. Verification shall be by inspection. An inspection of the as built drawings will be made to determine that the cameras are equipped with bumper rings per 3.1.1.4.1.D. Verification shall be considered successful when inspection shows that no damage is insued when the camera impacts the scratch pane.

4.3.1.1.5 SAFETY CRITICAL STRUCTURES REQUIREMENTS

Verification shall be in accordance with the requirements specified in SSP 52005.

4.3.1.1.6 CONNECTOR AND UMBILICAL PHYSICAL MATE

4.3.1.1.6.1 CONNECTOR PHYSICAL MATE

Verification that the integrated rack connector physically mates with the corresponding module connector shall be by demonstration. The demonstration shall use a module connector with the part number specified in Table 3.1.1.6.1–1 to verify that the connectors physically mate. The verification shall be considered successful when the demonstration shows the integrated rack connector physically mates with its corresponding module connector.

4.3.1.1.6.2 UMBILICAL PHYSICAL MATE

A demonstration shall be conducted using the Payload Rack Checkout Unit (PRCU) or equivalent to show that the umbilicals can successfully reach their intended connector and the connectors are observed in a fully mated condition.

4.3.1.1.7 ON ORBIT PAYLOAD PROTRUSIONS

A. An inspection shall be performed to determine that on–orbit protrusions do not extend laterally across the edges of the rack or pass between racks. The inspection shall be of the hardware or the as built drawings. The verification shall be considered successful when the inspection shows that no on–orbit protrusions extends extend laterally across the edges of the rack or pass between racks.

B. Verification that the integrated rack hardware does not preclude the attachment of RMA to the seat track shall be by demonstration or analysis. The demonstration shall be on the flight hardware or a flight like equivalent. The verification shall be considered successful when the demonstration shows that integrated rack hardware does not prevent attachment of RMA on the seat track for each discrete operational configuration of the rack.

   The analysis will consist of an assessment of each discrete operational configuration of the integrated rack based upon the as–built hardware drawings. The verification shall be considered successful when the analysis shows that the integrated rack hardware does not prevent attachment of RMA on the seat track for each discrete operational configuration.

4.3.1.1.7.1 ON–ORBIT PERMANENT PROTRUSIONS

An inspection of the integrated rack shall be conducted to determine that there are no permanent protrusions. The inspection shall be of the hardware or the as built drawings. The verification shall be considered successful when the inspection shows that there are no permanent protrusions.

4.3.1.1.7.2 ON–ORBIT SEMI–PERMANENT PROTRUSIONS

A. An inspection of the integrated rack shall be conducted to determine SIR and ISIS drawer handles remain within the envelope shown in Figure 3.1.1.7.2–1. The inspection shall be of the hardware or the as built drawings. The verification shall be considered successful when the inspection shows that all SIR and ISIS drawer handles remain within the envelope shown in Figure 3.1.1.7.2–1.

B. Verification of the other on–orbit semi–permanent protrusions, including knobs, switches, guards, quick–disconnect fittings, etc., of the integrated rack shall be performed by inspection. The inspection shall be of the as built drawings or hardware. Verification shall be considered successful when the inspection shows that all on–orbit semi–permanent protrusions including knobs, switches, guards, quick–disconnect fittings, etc., are limited to a total of 500 square inches within the envelope shown in Figure 3.1.1.7.2.2

C. Verification that the on–orbit semi–permanent protrusions are removable with hand operations and/or standard IVA tools shall be performed by demonstration. The demonstration shall be performed on the hardware. The verification shall be considered successful when the on–orbit semi–permanent protrusion can be removed with hand operations and/or standard IVA tools.

4.3.1.1.7.3 ON–ORBIT TEMPORARY PROTRUSIONS

A. An inspection of the integrated rack shall be conducted to determine that all on–orbit temporary protrusions remain within the envelope shown in Figure 3.1.1.7.3–1. The inspection shall be of the hardware or the as built drawings. The verification shall be considered successful when the inspection shows that all on–orbit temporary protrusions remain within the envelope shown in Figure 3.1.1.7.3–1.

B. Verification that the on–orbit temporary protrusions have been designed such that they can be eliminated or returned to their stowed configuration using hand operations and/or standard IVA tools within 10 minutes shall be performed by demonstration. The demonstration shall be performed on the hardware or a flight like equivalent. The verification shall be considered successful when the on–orbit temporary protrusions have been designed such that they can be eliminated or returned to their stowed configuration using hand operations and/or standard IVA tools within 10 minutes. To simulate on–orbit conditions, assume the ground based protrusion removal require half the time of on–orbit protrusion removal and that the tools are readily available.

4.3.1.1.7.4 ON–ORBIT MOMENTARY PROTRUSIONS

Verification of the on–orbit momentary protrusions, which includes drawer/door/cover, shall be by demonstration. The demonstration shall be performed on the hardware or a flight like equivalent. The verification shall be considered successful when the demonstration shows that the on–orbit momentary protrusion can be eliminated within the integrated rack within 30 seconds.

4.3.1.1.7.5 ON–ORBIT PROTRUSIONS FOR KEEP ALIVE PAYLOADS

A. Verification for on–orbit protrusions for keep–alive payload experiments shall be by inspection of the hardware or the as–built drawings. Verification shall be considered successful when the inspection shows that the power/data cables and thermal hoses are limited to no more than 500 square inches within the envelope shown in Figure 3.1.1.7.5–1.

B. The following two verification requirements are applicable only to the Habitat Holding Racks, Advanced Animal Habitat, Aquatic Habitat, Cell Culture Unit, Egg Incubator, Insect Habitat, Plant Research Unit, Incubator, and Refrigerated Centrifuge.

   (1) Verification shall be by an inspection of the hardware or the as–built drawings. Verification shall be considered successful when the inspection shows that the mated low temperature fluid line connectors and associated connection hardware are limited to no more than 100 square inches within the envelope shown in Figure 3.1.1.7.5–2.

   (2) Verification shall be by an inspection of the hardware or the as–built drawings. Verification shall be considered successful when the inspection shows that the air filters and low temperature fluid lines are limited to no more than 900 square inches within the envelope shown in Figure 3.1.1.7.5–3.

4.3.1.2 MICROGRAVITY

NVR

Hardware which will remain on–orbit after UF–3 should be verified to the subsequent requirements prior to launch.

4.3.1.2.1 QUASI-STEADY REQUIREMENTS

Forces produced by a payload below 0.01 Hz shall be verified by analysis against 3.1.2.1. This analysis shall be considered successful when it is shown that no impulse is exerted by the payload to the ISS, either directly or through the ISS vent/exhaust systems, greater than 10 lb–s (44 N–s) over any 10 to 500 second interval.

4.3.1.2.2 MECHANICAL VIBRATION

Verification of non–isolated rack mechanical vibration against 3.1.2.2 shall be accomplished by Finite Element Modeling (FEM), Statistical Energy Analysis (SEA), test or simplified analysis as discussed in the following paragraphs. SEA may be performed where sufficient modal density is present as defined by the SEA parameter limitations explanation included with the SEA model. FEM analysis may be performed to either the ISS side of the rack attachment brackets interface using a force limit requirement of Table 3.1.2.2–1 or to an assumed adjacent ARIS rack interface using the interface acceleration limit requirement of Table 3.1.2.2–2. In applying these methods, the following are to be observed:

1. Payload FEM models must use a damping factor of 0.5% unless alternative damping values are shown appropriate by test. Damping coefficient test data must be obtained using force levels no greater than the maximum disturbance force allowable to meet microgravity requirements and at the approximate location for the payload disturbance. High strain producing test methods are to be avoided since such test may increase damping, leading to misleading results.

2. The one–third octave force limits include allowance for payload frequency deviation as large as 10% from predicted or measured values. Payloads with disturbance frequency variation and uncertainty which exceeds 10% shall use worst–case assumptions for frequency disturbance close to one–third octave boundaries.

3. If multiple disturbance sources that are not phase synchronized are modeled, then the effect of each source operating independently is to be added in RSS fashion. If the disturbance sources are phase synchronized then the sum of the vibration contributions for each disturber in phase must be added at each resultant point in each axis prior to obtaining the RSS.

4. To ensure capture of modal peak responses in finite element frequency domain verification procedures, the transfer function and/or response analysis should explicitly include the modal frequencies of the finite element model. These should be supplemented with additional frequencies to adequately capture off–peak responses. It is required that the supplemental frequency density be sufficient to include at least one additional frequency within the half–power bandwidth of the modes. A constant logarithmic frequency spacing in which the delta frequency factor (deltafreq=deltafreqfac*lastfreq) is less than the half–power bandwidth (halfpowbw=2*c/ccrit) provides such a condition.

5. For the frequency range above 50 Hz, either SEA or FEM may be used. SEA models shall use a loss factor coefficient of 0.5% unless alternative values are justified by payload test FEM models are to be used to the highest frequency verified by test. FEM models may also be used beyond the range verifiable by test to envelope possible rack response as an alternative to SEA. The RSS of each one–third octave band plus one fourth of the RSS of each adjacent band as obtained by rack models applied to measured rack disturbances may be used to envelope FEM force response in the extended frequency range. Test data analysis

may be used to adjust the damping coefficient used in either FEM or SEA models or to adjust the coupling coefficients and loss factor used for SEA models.

6. Disturbance forces must be applied to transfer functions from Force Spectral Density (FSD) form for each one–third octave. The RSS value for each incremental division of FSD(f) contribution of multiple sources, wide–band and narrow–band, are to be added to yield a total FSD(f) for each frequency subdivision before Frms is calculated. Values are given either as wide–band (an RMS value and a frequency range) or as narrow–band (an rms value and a discrete frequency). Wide–band RMS one–third octave data are to be converted to FSD(f) per the following equation:

$$FSD(f) = \frac{Frms^2}{\Delta fto}$$

   Where Frms is the Data base rms force value and Δfto is the bandwidth of the one–third octave band. Narrow–band data base values are to be converted to FSD(f) by the same expression adding the data base rms value only in the single frequency subdivision spanning the data base frequency. The FSD(f) contribution for multiple sources, wideband and narrowband, are to be added to yield a total FSD(f) for each frequency subdivision before Frms is calculated.

The method used for combining results to obtain peak rms for each one–third octave is dependent upon the verification method used. Method A will be used for payloads employing the interface force method and Method B will be used for payloads employing integrated payload and ISS models.

PAYLOAD INTERFACE FORCE METHOD
Verification of the vibratory requirements shall be analysis or test. Acceptable methods for performing vibration test are contained in SSP 57010, Appendix E (Microgravity Control Plan).

The following sequence is to be used to verify integrated non–ARIS rack or latched ARIS rack compliance with section 3.1.2.2.1:

1. Obtain disturbance forces in Force Spectral Density (FSD) for each one–third octave.

2. Calculate rms force magnitude within each one–third octave at each payload attachment interface as the RSS of X, Y and Z components (rms force) in each one–third octave band. This is to be calculated by combining N frequency subdivisions of each one–third octave per the following equation:

$$Frms = \left(\sum_{N} H(f)^2 \cdot FSD(f) \right)^{\frac{1}{2}}$$

Where H(f) is the transfer function in lb/lb obtained by the FEM model for each frequency subdivision and FSD(f), is the Force Spectral Density forcing function for each frequency subdivision. The appropriate analytical model shall include the effects of the integrated payload rack and its attachment using a Payload Project Office provided interface model.

3. Find the combined force from all payload attachment interfaces at the RSS of all interface point forces (the results of A above) summed over each one–third octave bands.

4. Compare the combined force with the force limits in Figure 3.1.2.2–1. The wide–band limit may be used if the peak/average ratio is less than 5, otherwise the narrow–band peak limit must be used.

Verification is successful when the analysis or test results show that the interface forces are less than the limits specified in 3.1.2.2.

ADJACENT ARIS PAYLOAD ACCELERATION METHOD
Verification by this technique requires that the payload developer determine the ARIS interface accelerations resulting from the worst case combination of payload disturbance sources. This method is applicable for all pressurized payloads, including ARIS integrated racks, non–ARIS integrated racks and non–rack payloads. Application of this method requires integration of an ISS Payload Office provided interface model with payload developer FEM and/or SEA models. Verification of ARIS accelerations is to be performed by the following steps:

1. Obtain disturbance forces in Force Spectral Density (FSD) for each on–third octave.

2. Calculate rms acceleration magnitude within each one–third octave at each payload attachment interface as the RSS of X, Y and Z components (rms acceleration) in each one–third octave band. This is to be performed using unit forces applied in the X, Y and Z direction separately. The X, Y and Z components for each direction as a transfer function are to be calculated for all frequencies of interest. The FSD is to be applied to each transfer function yielding force magnitude is to be calculated for each 1/3rd octave by combining N frequency subdivisions of each one–third octave per the following equation:

$$Arms = \left(\sum_{N} H(f)^2 \cdot FSD(f) \right)^{\frac{1}{2}}$$

Where H(f) is the transfer function in ug/lb obtained by the FEM model for each frequency subdivision and FSD(f), is the Force Spectral Density forcing function for each frequency subdivision.

3. Find the combined acceleration from all payload attachment interfaces as the RSS of all interface point accelerations (the results of A above) summed over each one–third octave bands.

If the source direction is unknown then the largest response envelope resulting from applying the

$$\text{Asum} = \left[\frac{\sum\limits_{Np} \sum\limits_{(X,Y,Z)} \sum\limits_{Ns} \text{Amag}^2}{Np} \right]^{0.5}$$

magnitude in each axis is to be determined. Verification will be considered successful if the RMS Average of accelerations at the ARIS interface points from all sources, at all interface points, and all axis does not exceed the limits defined in Table 3.1.2.2–2. The following equation describes this summation process:

Where:
Amag is the X, Y or Z magnitude of model output acceleration at each interface point
Ns is the number of sources
Np is the number of ARIS interface points
Asum is the RMS acceleration to be compared with Table 3.1.2.2–2 for each one–third octave.

4.3.1.2.3 TRANSIENT REQUIREMENTS

Verification of the maximum transient impulse limit is to be performed by Method A. Verification of maximum force limit is to be performed by Method B.

A. Verification of maximum transient impulse shall be by analysis or test. Acceptable test methods are defined in SSP 57010, Appendix E. Verification shall be considered successful when the impulse delivered by an integrated rack or non–rack payload over any 10 second period is shown to be less than 10 lb s (44 N s) and when the sum of the impulse and vibration resulting from the impulse do not exceed the vibratory limits of 3.1.2.2 over any 100 second period. FEM time domain analysis is an acceptable verification method for this requirement as defined in 4.3.1.2.2. Acceleration or force response test data is acceptable if interface impedance considerations are included, including adjustment for possible modal frequency shift and interface structural amplification or attenuation.

B. The maximum force at the integrated rack or non–rack payload interface, as determined by either analysis or test, shall be less than 1000 lb (4448 N) in any direction. Rigid body analysis may be used if it can be shown that the rigid payload force to a rigid interface will not exceed 500 lb (2224 N). Otherwise, FEM payload analysis using a Payload Project Office supplied ISS model must be used to shown that the flexible interface force will not exceed 1000 lb (4448 N).

4.3.1.2.4 MICROGRAVITY ENVIRONMENT

NVR

4.3.1.2.5 ARIS ON–BOARD TO OFF–BOARD VIBRATORY REQUIREMENT

The general verification requirements of 4.3.1.2.2 are applicable. Rigid Body assumptions may be made if disturbance frequencies are below the first rack mode. Under baseline ARIS control parameters are used for ISS Stage 5A, the on–board to off–board limits of 3.1.2.5.1–3 are most restrictive at low frequencies and the sensor saturation limits are most restrictive at high frequencies. Allowing for the middle frequency range which may affect either requirement, the on–board to off–board analysis may be limited to the low frequency range below 15 and the sensor saturation verification range may be limited to frequencies above 2 Hz. Consequently, based upon assumed payload use of the standard ARIS control parameters, verification may be simplified to meeting the following processes:

<u>Rigid Body Analysis Method</u>
Assuming that the first free–free ARIS mode is greater than 17 Hz, rigid body analysis is sufficient using payload mass properties and know disturbance forces. Effective ARIS interface force shall be calculated by the following method:

1. Obtain frequency domain representations of all input forces by direction and one–third octave. This is to include both narrow–band sources and wide–band sources and the 100 second rms frequency domain representation of transients.

2. Obtain the effective forces due to moments by dividing each moment by the characteristic distance for the moment direction. The characteristics distances are 3 ft (0.91 m) for moments about the rack X and Y axis, and 1.50 ft (0.46 m) for moments about the rack Z axis.

3. The forces and effective forces are to be summed by RSS in the frequency domain of force and effective force by axis.

4. The results are to be summed by RSS of the contribution along each axis in the frequency domain.

5. Compare the results against the allowable limits of Table 3.1.2.5–1. The wide–band limit may be used if the peak/average ratio is less than 5, otherwise the narrow–band peak limit must be used.

FEM Analysis Method

If the ARIS payload has modes below 17 Hz under operational free–free conditions then FEM analysis will be required. FEM analysis shall be performed using the following method:

1. Obtain frequency domain representations of all input forces by direction and one–third octave. This is to include narrow–band sources, wide–band sources and the 100 second rms frequency domain representation of transients. If RMS input vs frequency data is used, this is to be converted to Frequency Spectral Density (FSD) by guideline 6 of 4.3.1.2.2.

2. Determine the acceleration response at each ARIS actuator interface point and at the center of the umbilical panel.

3. The accelerations are to be summed for each one–third octave as the RSS of all frequencies within each one–third octave by the following equation:

$$\mathrm{Arms} = \left[\sum_{(x,y,z)} \sum_{N} A(d,n)^2 \right]^{\frac{1}{2}}$$

   Where A(d,n) is the acceleration by direction (d) and interface point (n).

4. Compare the results against the allowable limits of Table 3.1.2.5–1. The wide–band limit may be used if the peak/average ratio is less than 5. Otherwise the narrow–band peak limit must be used.

4.3.1.2.6 ANGULAR MOMENTUM LIMITS

NVR

4.3.1.2.6.1 LIMIT INDUCED ISS ATTITUDE RATE

This requirement shall be verified by analysis. The analysis shall consist of a comparison of the calculated angular momentum impulse due to individual payload on–board disturbances to the per axis angular momentum allocations to verify that the allocations are not exceeded. The disturbance angular momentum impulse will normally be calculated as the integral of the disturbance torque relative to the ISS Assembly Complete center of mass over the specified period of time. For constant, continuously increasing, or continuously decreasing disturbance torques over two or more adjacent time periods, the difference in angular momentum impulse of the adjacent time periods should be used. Each integrated rack or non–rack payload source may be verified independently against the nine minute limit. Each integrated rack or non–rack payload shall be verified under worst–case combined source conditions against the two minute and ten second limits. ISS assembly complete mass properties and worst case element location/design parameters should be used when assessing compliance with this requirement. The verification shall be considered successful when analysis shows that the per axis disturbance angular momentum impulses are as specified for each axis.

4.3.1.2.6.2 LIMIT DISTURBANCE INDUCED CMG MOMENT USAGE

This requirement shall be verified by analysis utilizing analytical models of the disturbance. This analysis shall consist of calculating the angular momentum impulse for each axis due to individual payload on–board disturbances and applying them in the specified equation for estimating worst case CMG momentum usage. The disturbance angular momentum impulse will normally be calculated as the integral of the disturbance torque relative to the ISS Assembly Complete center of mass over the specified period of time. For constant, continuously increasing, or continuously decreasing disturbance torques over two or more adjacent 110 minute periods, the difference in angular momentum impulse of the adjacent 110 minute periods should be used. ISS assembly complete mass properties and worst case element location/design parameters (location and orientation producing the greatest H impulse vector with respect to the requirement of Table 3.1.2.6–2) should be used when assessing compliance with this requirement. The verification shall be considered successful when analysis shows that the estimated worst case CMG momentum usage is less than the specified amount.

4.3.1.3 STOWAGE

Information only. No verification required.

4.3.2 ELECTRICAL INTERFACE REQUIREMENTS

NVR

4.3.2.1 ELECTRICAL POWER CHARACTERISTICS

NVR

4.3.2.1.1 STEADY-STATE VOLTAGE CHARACTERISTICS

NVR

4.3.2.1.1.1 INTERFACE B

Interface B steady-state voltage requirements shall be verified by test.

Verification of compatibility with steady-state voltage limits shall be performed by test at low and high input voltage values of 116 to 126 Vdc. The integrated rack shall be operated under selected loading conditions that envelope the operational loading.

The verification shall be considered successful when the test shows under low and high voltage conditions the integrated rack is compatible with the steady-state voltage limits of 116 to 126 Vdc.

Verification may be performed by the PRCU or equivalent.

4.3.2.1.1.2 INTERFACE C

Interface C steady-state voltage requirements shall be verified by test.

Verification of compatibility with steady-state voltage limits shall be performed by test at low and high input voltage values of 113 to 126 Vdc. The EPCE shall be operated under selected loading conditions that envelope operational loading.

The verification shall be considered successful when the test shows under low and high voltage conditions the EPCE is compatible with the steady-state voltage limits of 113 to 126 Vdc.

Verification may be performed by the PRCU or equivalent.

4.3.2.1.2 RIPPLE VOLTAGE CHARACTERISTICS

NVR

4.3.2.1.2.1 RIPPLE VOLTAGE AND NOISE

Ripple Voltage and Noise requirements shall be verified by analysis.

The verification shall be considered successful when the CS–01 test shows the integrated rack connected to interface B and EPCE (or Integrated rack in MPLM) connected to interface C operate and are compatible with the EPS time domain ripple voltage and noise level of at least 2.5 Vrms within the frequency range of 30 Hz to 10k Hz.

4.3.2.1.2.2 RIPPLE VOLTAGE SPECTRUM

Ripple Voltage Spectrum requirements shall be verified by analysis.

Verification shall be considered successful when analysis of the CS–01 and CS–02 test data shows the integrated rack connected to interface B and EPCE (or Integrated rack in MPLM) connected to interface C operates and is compatible with the ripple voltage spectrum in Figure 3.2.1.2.2–1 of this document.

4.3.2.1.3 TRANSIENT VOLTAGES

NVR

4.3.2.1.3.1 INTERFACE B

Transient Voltage requirements shall be verified by test or analysis.

Input voltage shall be 116 Vdc and 126 Vdc with the Interface B source impedance, as specified in SSP 30482, Volume I.

Verification of compatibility with the specified Transient Voltages shall be performed by test or analysis of the integrated rack operation across the transient envelope as specified in Figure 3.2.1.3.1–1 of this document.

The verification shall be considered successful when the test or analysis shows the integrated rack is compatible with the EPS transient voltage characteristics as specified in Figure 3.2.1.3.1–1.

4.3.2.1.3.2 INTERFACE C

Transient Voltage requirements shall be verified by test or analysis.

Input voltage shall be 113 Vdc and 126 Vdc with the Interface C source impedance, as specified in SSP 30482, Volume I.

Verification of compatibility with the specified Transient Voltages shall be performed by test or analysis of EPCE operation across the transient envelope as specified in Figure 3.2.1.3.2–1 of this document.

The verification shall be considered successful when the test or analysis shows the EPCE is compatible with the EPS transient voltage characteristics as specified in Figure 3.2.1.3.2–1.

4.3.2.1.3.3 FAULT CLEARING AND PROTECTION

Fault Clearing and Protection shall be verified by analysis.

The verification shall be considered successful when analysis shows the integrated rack at Interface B and EPCE at Interface C does not produce an unsafe condition or one that could result in damage to ISS equipment or payload hardware from the EPS transient voltages as specified in Figure 3.2.1.3.3–1 of this document.

4.3.2.1.3.4 NON-NORMAL VOLTAGE RANGE

The following verification requirements are applicable to paragraph 3.2.1.3.4A and B.

Verification of compatibility with Non-Normal voltage range conditions shall be performed by analysis. The analysis shall ensure the integrated rack or EPCE will not produce an unsafe condition or one that could result in damage to ISS equipment external to the integrated rack or EPCE when parameters are as specified in paragraph 3.2.1.3.4. The analysis should be performed with all converters directly downstream of Interface B or Interface C.

The verification shall be considered successful when analysis shows the integrated rack or EPCE is safe within ISS interface conditions as defined in paragraph 3.2.1.3.4.

4.3.2.2 ELECTRICAL POWER INTERFACE

NVR

4.3.2.2.1 UIP, UOP AND SUP CONNECTORS AND PIN ASSIGNMENTS

A. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

B. Verification of P1 and P2 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P1 and P2 pinouts match the corresponding J1 and J2 pinouts. The verification shall be considered successful when the inspection shows that the P1 and P2 connector pinout is appropriate.

C. Verification of the P1 and P2 connector with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P1 and P2 connectors.

D. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

E. Verification of P3 and P4 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P3 and P4 pinouts match the corresponding J3 and J4 pinouts. The verification shall be considered successful when the inspection shows that the P3 and P4 connector pinout is appropriate.

F. Verification of the P3 and P4 connectors with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P3 and P4 connectors.

G. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1

H. Verification of P1, P2 and P3 pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P1, P2 and P3 pinouts match the corresponding J1, J2 and J3 pinouts. The verification shall be considered successful when the inspection shows that the P1, P2 and P3 connector pinouts are compatible with J1, J2 and J3 pinouts.

I. Verification of the P1, P2 and P3 connectors with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P1, P2 and P3 connectors.

4.3.2.2.2 POWER BUS ISOLATION

A. Verification of Power Bus Isolation between two independent ISS Power Buses as specified, shall be performed by analysis. The verification shall be considered successful when the analysis shows the integrated rack, with a source voltage of + 126 Vdc, and its internal and external EPCE provides a minimum of 1–megohm isolation in parallel with not more than 0.03 microfarads of mutual capacitance between the two independent power buses including both the supply and return lines.

B. Verification of Power Bus Isolation without the use of diodes shall be verified by analysis. The analysis shall show the exclusion of diodes used to isolate the two independent ISS power bus high side or return lines. The verification shall be considered successful when analysis shows there are no diodes used, to electrically tie together independent ISS power bus high side or return lines, within the integrated rack and its internal and external EPCE.

4.3.2.2.3 COMPATIBILITY WITH SOFT START/STOP RPC

Compatibility with Soft Start/Stop RPC(s) shall be verified by test.

Verification of initialization with soft start/stop performance characteristics shall be performed by test when the initial supply of power is provided to the equipment connected to the RPC(s). Input power to the payload EPCE shall be delivered through a PRCU or equivalent. The EPCE connected to interface B or C shall be operated with multiple load combinations at levels ranging from 0% to 100% of the RPC rated conductivity.

The verification shall be considered successful when test shows the EPCE can initialize operation and prove compatibility with the soft start/stop RPC characteristics, representative of Figure 3.2.2.3–1, as specified in paragraph 3.2.2.3.

4.3.2.2.4 SURGE CURRENT

Surge Current shall be verified by test and analysis.

Input power to the integrated rack or EPCE should be representative of the ISS power environment.

Verification of compatibility with Surge Current limits shall be performed by test at high and low input voltage values as specified. The power source used to perform the test shall be capable of providing a range of power between 0 kW to 6 kW at 116–126 Vdc for Interface B connected equipment and 0 kW to 1.44 kW at 113–126 Vdc for Interface C connected equipment. The EPCE shall be operated under selected loading conditions that envelope operational loading. The analysis shall be performed using test data from the above test. The analysis shall indicate operability and compatibility exist based on test data and the requirements specified in paragraph 3.2.2.4.

The verification shall be considered successful when test and analysis shows under high and low voltage conditions the EPCE can perform all functional capabilities and prove compatibility by operating within the specified limits of paragraph 3.2.2.4.

4.3.2.2.5 REVERSE CURRENT

NVR

4.3.2.2.5.1 REVERSE CURRENT LIMITS

Reverse current limits requirements shall be verified by analysis.

If the integrated rack or EPCE connected to US Type I RPCMs have aggregated input connected capacitance less than 25 micro–farads, no verification is required.

Input power to the integrated rack or EPCE should be representative of the ISS power environment.

Verification of compatibility with reverse current limits shall be performed by analysis. The input voltages prior to the occurrence of fault shall be 116V and 126V for Integrated Rack connected to Interface B and 113 V and 126 V for EPCE connected to interface C. The integrated rack or EPCE shall be analyzed under selected loading conditions that envelope operational loading.

The verification will be considered successful when analysis shows that the integrated rack or EPCE complies with requirements defined in paragraphs 3.2.2.5.1 for the reverse current into the upstream power source.

4.3.2.2.5.2 TRANSIENTS PARTIALLY CONTAINED WITHIN THE ENVELOPE

If the integrated rack or EPCE meets the requirements in paragraph 3.2.2.5.1, no verification is required.

If the reverse current exceeds the envelope limits defined in paragraph 3.2.2.5.1 for one or more short time intervals, the requirement for reverse current transients partially contained within the envelope shall be verified by analysis.

The verification will be considered successful when analysis shows that the integrated rack or EPCE complies with requirement defined in paragraph 3.2.2.5.2 for the reverse current exceeding the envelope limits defined in paragraph 3.2.2.5.1 for one or more short time intervals.

4.3.2.2.6 CIRCUIT PROTECTION DEVICES

NVR

4.3.2.2.6.1 ISS EPS CIRCUIT PROTECTION CHARACTERISTICS

NVR

4.3.2.2.6.1.1 REMOTE POWER CONTROLLERS (RPCs)

A. Analysis of the test data required by paragraph 4.3.2.2.4 shall be performed to show the integrated rack connected to an Interface B ISPR location operates and is compatible with the characteristics shown and described in SSP 57001 Figures 3.2.6–2, 3.2.6–3, 3.2.6–4 and paragraph 3.2.6. The analysis shall be performed at initiation of power to the integrated rack and with multiple internal load combinations that include, but are not limited to sub-rack payloads. The verification shall be considered successful if the analysis results show the initial current flow, when powered “on”, to the integrated rack and current flow during the integrated rack operations with multiple internal load combinations including sub-rack payloads does not exceed the current magnitude and duration as defined and described in SSP 57001 Figures 3.2.6–2, 3.6.2–3, 3.6.2–4 and paragraph 3.2.6.

B. Analysis of the test data required by paragraph 4.3.2.2.4 shall be performed to show the integrated rack connected to a MPLM powered rack location operates and is compatible with the characteristics shown and described in SSP 57001 Figure 3.2.6–6 and paragraph 3.2.6. The analysis shall be performed at initiation of power to the integrated rack and with multiple internal load combinations that include, but are not limited to sub-rack payloads. The verification shall be considered successful if the analysis results show the initial current flow, when powered “on”, to the integrated rack and current flow during the integrated rack operations with multiple internal load combinations including sub-rack payloads does not exceed the current magnitude and duration as defined and described in SSP 57001 Figure 3.2.6–6 and paragraph 3.2.6.

C. Analysis of the test data required by paragraph 4.3.2.2.4 shall be performed to show the EPCE connected to a UOP location operates and is compatible with the characteristics shown and described in SSP 57001 Figure 3.2.6–5 and paragraph 3.2.6. The analysis shall be performed at initiation of power to the EPCE and with load combinations for which the EPCE is designed. The verification shall be considered successful if the analysis results show the initial current flow, when powered “on”, to the EPCE and current flow during the EPCE operations with load combinations does not exceed the current magnitude and duration as defined and described in SSP 57001 Figure 3.2.6–5 and paragraph 3.2.6.

D. Analysis of electrical circuit schematics shall be performed to show overcurrent protection exists at all points in the payload electrical architecture system where power is distributed to lower level (wire size not protected by upstream circuit protection device) feeder and branch lines. The analysis shall be considered successful when results show overcurrent protection exists at each point in the payload electrical architecture system where power is distributed to lower level (wire size) feeder and branch lines.

E. Analysis of electrical circuit schematics shall be performed to show current limiting overcurrent protection exists for all internal loads drawing power from an interface B power feed(s). The analysis shall be considered successful when results show current limiting overcurrent protection exists in the distribution paths to all load devices connected to an interface B power feed(s).

4.3.2.2.6.2 EPCE RPC INTERFACE REQUIREMENTS

NVR

4.3.2.2.6.2.1 RPC TRIP COORDINATION

NVR

4.3.2.2.6.2.1.1 PAYLOAD TRIP RATINGS

The integrated rack or EPCE Trip Ratings shall be verified by analysis.

An analysis shall be performed for the integrated rack connected to Interface B. The analysis will compare the current rating and trip characteristics of the circuit protection device in the integrated rack to the current rating and trip characteristics of the upstream RPC.

The verification shall be considered successful when analysis shows that the circuit protection device in the integrated rack will trip before the upstream RPC.

4.3.2.2.7 EPCE COMPLEX LOAD IMPEDANCES

NVR

4.3.2.2.7.1 INTERFACE B

The following verification requirements apply to paragraph 3.2.2.7.1A and B.

Integrated rack complex load impedance(s) shall be verified by test. *

* Verification may be performed by the PRCU or equivalent only if the PRCU or equivalent meets SSP 30482 Volume 1, Rev. C, source impedance requirements.

All active converters directly downstream of interface B shall be qualification or flight hardware. Loading of the downstream converter(s) can be simulated to provide full range of active converter loading.

Load impedance shall be tested under conditions of high and low voltage to the integrated rack and with these conditions for the active converters directly downstream shall be exercised through the complete range of their loading. Selected combinations of converters that can influence the measured load impedance at Interface B shall be tested.

The verification shall be considered successful when the test shows that all load impedances measured for high and low voltage conditions remain within specified limits.

4.3.2.2.7.2 INTERFACE C

EPCE complex load impedance(s) shall be verified by test. *

* Verification may be performed by the PRCU or equivalent only if the PRCU or equivalent meets SSP 30482 Volume 1, Rev. C, source impedance requirements.

All active converters directly downstream of interface B shall be qualification or flight hardware. Loading of the downstream converter(s) can be simulated to provide full range of active converter loading.

Load impedance shall be tested under conditions of high and low voltage to the integrated rack and with these conditions for the active converters directly downstream shall be exercised through the complete range of their loading. Selected combinations of converters that can influence the measured load impedance at Interface B shall be tested.

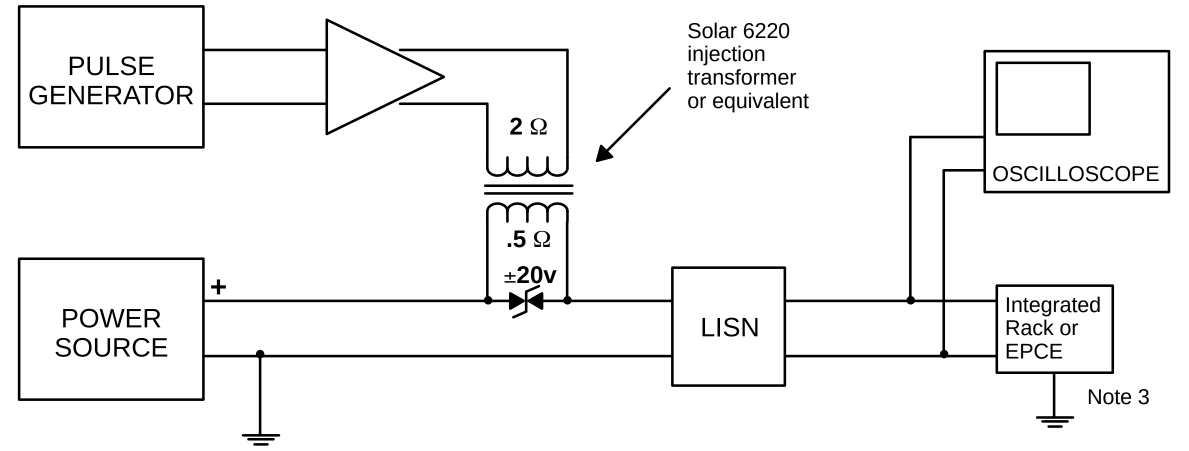
The verification shall be considered successful when the test shows that all load impedances measured for high and low voltage remain within specified limits.

4.3.2.2.8 LARGE SIGNAL STABILITY

Large signal stability shall be verified by test and analysis. A large signal stability test shall be conducted for the integrated rack connected to Interface B and EPCE connected to Interface C. An integrated analysis shall be provided by the rack integrator for representative maximum and minimum case loads to demonstrate that impedance variations will not impact system stability. The input and transient response waveform for the integrated rack and EPCE shall be recorded from the start of the pulse through the time when the transient diminishes to and remains below 10 percent of the maximum amplitude of the response.

The required test conditions may be produced using a programmable power source or the setup shown in Figure 4.3.2.2.8–1. The 25 amp and 50 amp LISN or equivalent is to be used for Integrated racks connecting to Interface B and the 12 amp LISN or equivalent is to be used for EPCE connecting to Interface C as shown in Figure 4.3.2.2.8–2. The pulse generator/amplifier must provide a source impedance of less than 0.2 ohms from 100 Hz to 10 kHz to the 2 ohm load of the primary side of the pulse transformer. Pulses of 100, 125 and 150 microsecond (±10 microsecond) duration shall be applied. The pulse amplitude at the secondary side of the injection transformer should be between 10 and 15 Volts. Pulse rise and fall times must not exceed 10 microseconds between 10 and 90 percent of the pulse amplitude. The resulting transient responses must remain within the EPS normal transient limits.

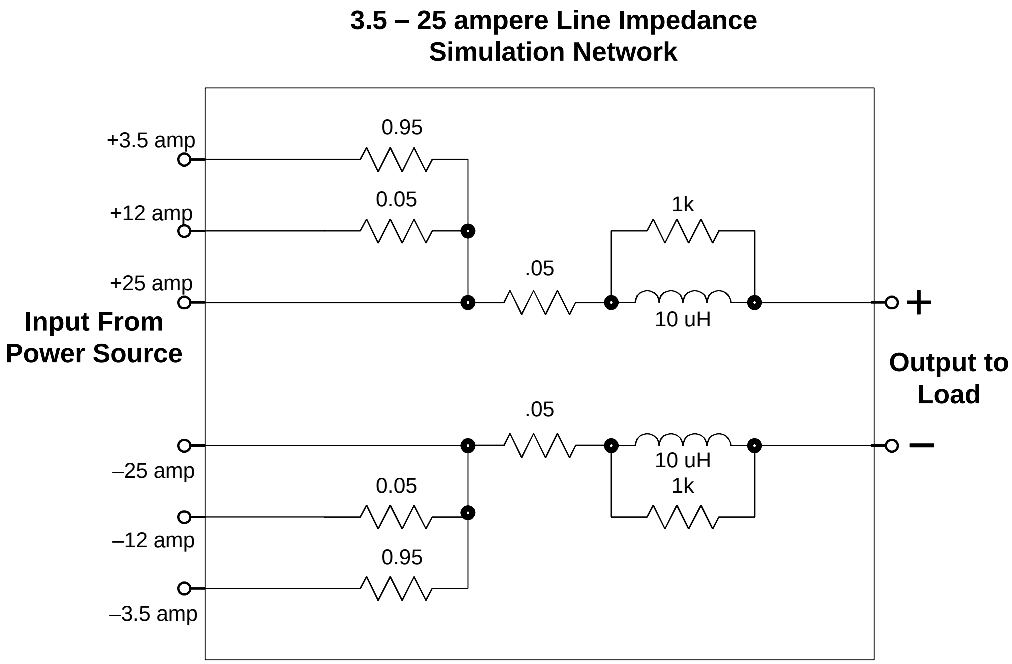
The test and analysis shall be considered successful when results show transient responses, measured at the input to integrated rack or EPCE, diminish to 10 percent of the maximum amplitude within 1.0 milliseconds and remain below 10 percent thereafter.

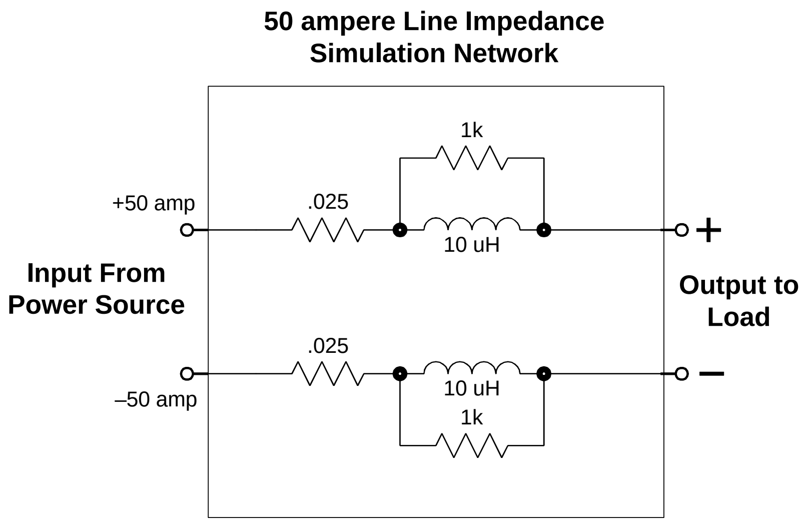


NOTES:

2. The output of the pulse generator must be applied to the transformer through a drive amplifier capable of providing an output impedance of 0.2 ohms, or less, from 100 Hz to 10 kHz.
3. The drive amplifier should be capable of delivering at least 75 watts rms into a 4 Ohm load and be suitable for EMC CS–01 tests.
4. Chassis of integrated rack must be grounded; portable equipment is not grounded.
5. Pulse generator, injection transformer and Zener diode may require adjustment to generate the test pulses and to protect the integrated rack or EPCE under test.

FIGURE 4.3.2.2.8–1 STABILITY TEST SETUP, TRANSIENT RESPONSES





Note: Resistance is in Ohms

FIGURE 4.3.2.2.8–2 ISS LINE IMPEDANCE SIMULATION NETWORK (LISN)

4.3.2.2.9 DELETED

4.3.2.2.10 ELECTRICAL LOAD-STAND ALONE STABILITY

Verification of local stability requirements is defined in paragraph 4.3.2.4.4.

The verification shall be considered successful when analysis of test data for the requirements identified in the following paragraphs are met:

A. Paragraph 3.2.2.1 of SSP 30237 (CS01)

B. Paragraph 3.2.2.2 of SSP 30237 (CS02)

C. Paragraph 3.2.2.3 of SSP 30237 (CS06)

4.3.2.2.11 DELETED

4.3.2.2.12 MAXIMUM LOAD STEP SIZE

Maximum load step size shall be verified by test.

Verification shall be by test for loads will operate from feeds rated for more than 25 amperes or 3 kilowatts. The test shall simulate all operational modes and related transitions for each power feed. The maximum change in power demand must be determined for each transition that is possible under normal operating conditions, and that can occur in less than 1 millisecond (measured between the 10 and 90 percent of transition points). In all cases, the power levels measured will be the average over any 10 millisecond, or greater, time interval. The test shall be considered successful if the test results show that a change in power does not exceed 3 kilowatts.

4.3.2.3 ELECTRICAL POWER CONSUMER CONSTRAINTS

NVR

4.3.2.3.1 WIRE DERATING

A. Derating for wire/cable between EPCE and the UOP shall be verified by analysis. Analysis of the electrical power schematics shall be performed to show that the wire between EPCE and UOP meets the derating requirements in SSP 30312. The verification shall be considered successful when the analysis shows the wire gauge meets the wire derating requirements in SSP 30312.

B. Wire derating for the EPCE at and downstream of the primary circuit protection device(s) in the integrated rack shall be verified by analysis. Analysis of the electrical power schematics shall be performed to show that the wire gauge of the integrated rack and EPCE meets the requirements of paragraph 3.2.3.1. The verification shall be considered successful when the analysis shows the integrated rack and EPCE meet the wire derating requirements as specified in NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA–92–038. Wire gauge meeting the requirements of SSP 30312 is accepted as meeting the requirements of NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA–92–038.

C. Wire size for the wire/cable from UIP to the primary circuit protection device(s) in ISPR shall be verified by inspection or analysis. Inspection or analysis of cable drawings shall be performed to show that the wire gauge meets the requirements specified in paragraph 3.2.3.1.C. The verification shall be considered successful when the inspection or analysis shows that 4 gauge wires are used for main and auxiliary connections from UIP to the primary circuit protection device(s) in ISPR.

4.3.2.3.2 EXCLUSIVE POWER FEEDS

The Exclusive Power Feeds requirement shall be verified by analysis of electrical circuit schematics. The analysis shall be considered successful when the electrical schematics show:

A. The integrated rack only receives power from the UIP dedicated to its rack location.

B. Cabling does not occur between Interface C connected EPCE with Interface B; and/or Interface B connected EPCE with interface C.

4.3.2.3.3 LOSS OF POWER

Verification that the equipment connected to Interface B or Interface C meets the loss of power safety requirements specified in NSTS 1700.7, ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.2.4 ELECTROMAGNETIC COMPATIBILITY

The Electromagnetic Compatibility (EMC) of the payload EPCE shall be verified by test, analysis and/or inspection. The test shall be considered successful when the results show that payload EMC is in compliance with the requirements of SSP 30243, paragraphs 3.1, 3.5, and 3.6.2. The analysis shall be based on end item qualification data and payload EPCE design and analysis data. The analysis shall be considered successful when the data shows the payload EPCE meets the EMC requirements of SSP 30243, paragraphs 3.1, 3.5, and 3.6.2. The inspection shall be based on physical/visual indications of the payload EPCE. The inspection shall be considered successful when physical/visual indications show the EMC requirements of SSP 30243, paragraph 3.1, 3.5, and 3.6.2 are met.

The requirements of SSP 30243 paragraphs 3.1 and 3.6.2 shall be verified by test and analysis. The test shall be considered successful when results show the integrated rack connected to Interface B and EPCE connected to Interface C meet the requirements specified in SSP 30243 paragraph 3.6.2. The results of the EMC test shall be documented in the EMC test plan/report.

The analysis shall be documented in an EMC Control Plan and Design Analysis Report. The analysis shall include determining the necessary requirements for equipment not connected directly to Interface B and Interface C such that the entire payload meets the EMC requirements of this IRD. The analysis shall be considered successful when results show that the requirements defined in section 3.1 of SSP 30243 have been met.

Note:

1. The Control Plan and the Design Analysis Report can be combined into one document per payload provider format.

2. Clarifications to SSP 30243, paragraph 3.6.2:

    - Only the impedance characteristics of the power source need to be simulated.
    - Only representative simulated signals and loads for the interface tests are required.
    - Verification of the on–orbit configuration of the integrated rack may be performed analytically if and only if the on–orbit configuration differs from the Qualification Test configuration.

3. Details of the EMC Control Plan, Design Analysis Report, and EMC Test Plan/Report are located in SSP 57010.

4. If analysis shows requirements of paragraph 3.6.2 of SSP 30243 are met during Integrated rack or multiple EPCE EMI testing, as defined in paragraph 3.2.4.4. of this document, a separated EMC test plan/report is not needed.

4.3.2.4.1 ELECTRICAL GROUNDING

The Electrical Grounding of the payload EPCE shall be verified by test and analysis. The test shall be considered successful when the results show that payload grounding is in compliance with the requirements in section 3 of SSP 30240. The analysis shall be based on end item qualification data and payload EPCE design and analysis data. The analysis shall be considered successful when the data shows the payload EPCE is electrically grounded within the requirements of section 3 of SSP 30240.

4.3.2.4.2 ELECTRICAL BONDING

The Electrical Bonding of the payload EPCE shall be verified by Test, Analysis and Inspection. The test shall be considered successful when the results show all requirements of SSP 30245 and the requirements of NSTS 1700.7, ISS Addendum in sections 213 and 220 are met. The analysis shall be based on end item qualification data and Payload EPCE design and analysis data. The analysis shall be considered successful when the data shows the payload EPCE is electrically bonded within the requirements of SSP 30245 and the requirements of NSTS 1700.7, ISS Addendum in sections 213 and 220 are met. The inspection shall be based on physical/visual indications of the payload EPCE. The inspection shall be considered successful when physical/visual indications show all requirements of SSP 30245 and the requirements of NSTS 1700.7, ISS Addendum in sections 213 and 220 are met.

4.3.2.4.3 CABLE/WIRE DESIGN AND CONTROL REQUIREMENTS

The Cable and Wire Design of the payload EPCE external cables shall be verified by T, A, or I. The test shall be considered successful when the results show all requirements of SSP 30242 are met. The analysis shall be based on payload EPCE design and analysis data. The analysis shall be considered successful when the results show all requirements of SSP 30242 are met. The inspection shall be based on physical/visual indications of the payload EPCE. The inspection shall be considered successful when physical/visual indications show that external cable and wire design is in compliance with the requirements of SSP 30242.

SSP 30242 harness requirements can normally be met by inspection of drawings and hardware. Analysis is required to classify signals and determine the necessary isolation between signals. Test may be required to determine impedance and sensitivity characteristics of the circuit when classification cannot be determined by examination of the circuit known characteristics.

4.3.2.4.4 ELECTROMAGNETIC INTERFERENCE

The Electromagnetic Interference of the payload EPCE shall be verified by test and analysis. Tests shall be performed and data submitted for conducted susceptibility and radiated susceptibility, in addition to that for conducted emissions and radiated emissions. This data shall be evaluated against the limits of SSP 30237.

The test results shall be documented in the EMI test plan/report. The test shall be considered successful when the results show requirements of SSP 30237 are met.

Note: EMI test plan/report details are located in SSP 57010.

The analysis of each integrated rack shall be performed using sub-integrated rack equipment test data as mentioned in the above paragraph. The analysis shall be considered successful when the results show requirements of SSP 30237 are met.

This analysis includes evaluating the degree of isolation from 30 Hz to 400 MHz provided by the EPCE for power ripple and transients to the equipment using isolated power. An analysis of the isolation in conjunction with the equipment conducted requirements should be submitted in the EMC Control Plan to verify the requirements of this IRD are met.

The EMI test methods shall be as specified in SSP 30238.

4.3.2.4.5 ELECTROSTATIC DISCHARGE

The susceptibility of the Electrostatic Discharge of the unpowered payload EPCE and its components shall be verified by test or analysis and inspection. The analysis shall be based on payload EPCE design and analysis data. The test or analysis shall be considered successful when the results show the requirement in paragraph 3.2.4.5 of this document is met. The inspection shall be based on physical/visual indication of the payload EPCE. The inspection shall be considered successful when physical/visual indications show the labeling of EPCE susceptible to ESD up to 15,000 V are in accordance with MIL–STD–1686.

4.3.2.4.6 ALTERNATING CURRENT (AC) MAGNETIC FIELDS

The AC magnetic fields requirement for payload equipment as defined in paragraph 3.2.4.6 shall be verified by test.

Test shall be performed using the MIL–STD–462D RE101 Method with the following modifications:

1. Test setup guidelines shall be per SSP 30238, Figure 3.2.3.1.4–1 or 3.2.3.1.4–2, not the setup identified by MIL–STD–462D.

2. Guidelines of SSP 30238, Figures 3.2.3.1.4–1 and 3.2.3.1.4–2, requirement of 1 meter separation does not apply to RE101.

3. Measurements are required from 30 Hz to 50 kHz rather than 100 kHz required by MIL–STD–461D.

4. Measurements are performed at 7 cm from a point on the enclosure of the generating equipment nearest the source of the field. In the event emissions are out–of–specification, measurements shall be performed at 10 cm from a point on the enclosure of the generating equipment and at 10 cm increments away perpendicular to the enclosure (surface) of the

generating equipment until data proves the AC magnetic fields are 6 dB less than the requirement in paragraph 3.2.4.6.

5. Emissions greater than 20 dB below the specified limits shall be recorded in the EMI test report. In cases where the noise floor and ambient are not 20 dB below specified level, only those emissions above the noise floor/ambient are required to be recorded.

The verification shall be considered successful when test results show the generated AC magnetic fields do not exceed the magnetic field emission limits of paragraph 3.2.4.6. A certificate of compliance stating the AC magnetic field does not exceed the design requirement will be sufficient for equipment that meets the requirement.

Note:

1. Requirements are not applicable to solenoid valves, solenoid relays, and electric motors with current of less than 1 Amp.
2. The composite testing for the integrated rack is not required if the EPCE or sub–rack payloads meet the requirements.

4.3.2.4.7 DIRECT CURRENT (DC) MAGNETIC FIELDS

The DC magnetic fields requirement for payload equipment as defined in 3.2.4.7 shall be verified by test.

The measurement of DC magnetic fields shall be performed at 7 cm from a point on the enclosure of the generating equipment nearest the source of the field. For integrated racks and equipment that exceed the design requirement of paragraph 3.2.4.7, measurements shall be performed at 10 cm from a point on the enclosure of the generating equipment until data proves the DC magnetic fields are less than 164 dBpT.

The verification shall be considered successful when test results show the generated DC magnetic fields do not exceed the design requirement of paragraph 3.2.4.7. A certificate of compliance stating the DC magnetic field does not exceed the design requirement will be sufficient for equipment that meets the requirement.

Note:

1. Requirements are not applicable to solenoid valves, solenoid relays, and electric motors with power consumption of less than 120 Watts.
2. The composite testing for the integrated rack is not required if the EPCE or sub–rack payloads meet the requirements.

4.3.2.4.8 CORONA

Equipment with voltages (steady–state, transient, internal, or external) greater than 190 volts or equipment containing gases mixture other than those present in the pressurized module shall be verified by analysis or test to the degree necessary to ensure no permanent damaging effects and no hazardous conditions due to destructive corona will exist in its operating environment. The operating environment is defined as normal pressurized atmosphere as specified in Table 3.9.4–1 or depressurized module if the payload is still powered. The fault clearing and protection voltage defined in Paragraph 3.2.1.3.3. is not considered the equipment voltage. If the equipment (with voltages greater than 190 volts) may be powered during depressurization, the verification shall be by test.

4.3.2.4.9 LIGHTNING

The Lightning requirement shall be verified by analysis.

The analysis shall be considered successful when the data shows that the integrated rack and EPCE is compatible with the requirements specified in paragraph 3.2.4.9. Note: The analysis data should be based on end item qualification design data and analysis data of the integrated rack or EPCE.

4.3.2.4.10 EMI SUSCEPTIBILITY FOR SAFETY-CRITICAL CIRCUITS

Test and analysis shall verify safety critical circuits. The analysis shall be considered successful when the results show the requirements of SSP 30243, paragraph 3.2.3 are met.

4.3.2.5 SAFETY REQUIREMENTS

NVR

4.3.2.5.1 PAYLOAD ELECTRICAL SAFETY

NVR

4.3.2.5.1.1 MATING/DEMATING OF POWERED CONNECTORS

Verification that the equipment connected to Interface B or Interface C meets the loss of power safety requirements specified in NSTS 1700.7, ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.2.5.1.2 SAFETY-CRITICAL CIRCUITS REDUNDANCY

Verification that the equipment connected to Interface B or Interface C meets the loss of power safety requirements specified in NSTS 1700.7, ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.2.5.2 RACK MAINTENANCE SWITCH (RACK POWER SWITCH)

A. Verification shall be by inspection. Verification shall be considered successful when the inspection shows the integrated rack is equipped with a guarded, two position, manually operated lever lock switch located on the front of the integrated rack.

B. Verification shall be by inspection. The inspection shall be of as–built wiring schematics. The verification shall be considered successful when the inspection demonstrates the switch provides an OPEN circuit while in the DOWN position and provides a CLOSED circuit while in the UP position.

C. Verification shall be by inspection. Verification shall be considered successful when the inspection of the drawings reveal that the proper label has been used. Review and approval, shall be granted by the ISS Payload Label Approved Team.

4.3.2.5.3 POWER SWITCHES/CONTROLS

The power switches/controls requirements shall be verified by analysis for power interfaces with open circuit voltage exceeding 30 volts rms or dc nominal (32 volts rms or dc maximum).

A. Switches/controls requirement shall be verified by analysis. An analysis shall be performed to ensure the switches/controls performing on/off functions for all power interfaces open (dead-face) all supply circuit conductors, except the power return and equipment grounding conductor, while in the power-off position. Verification shall be considered successful when analysis of electrical circuit schematics shows the switches/controls performing on/off power functions for all power interfaces open (dead-face) all supply conductors except the power return and equipment grounding conductor, while in the power-off position.

B. Power-off markings and/or indications requirement shall be verified by analysis. The analysis shall ensure power-off markings and/or indications exist when all electrical connections with the power supply circuit are disconnected. The verification shall be considered successful when analysis shows power switches/controls power-off markings and/or indication(s) exist when all electrical connections with the power supply circuit are disconnected.

C. Standby, charging and descriptive nomenclature requirement shall be verified by analysis. The analysis shall ensure the existence of descriptive nomenclature such as standby, charging, or that necessary to indicate the power supply circuit is not completely disconnected for this power condition. The verification shall be considered successful when analysis shows descriptive nomenclature exists to indicate the power supply circuit is not completely disconnected.

4.3.2.5.4 DELETED

4.3.2.5.5 PORTABLE EQUIPMENT/POWER CORDS

A. Analysis of schematics shall ensure non-battery powered portable equipment, incorporates a three-wire power cord containing a supply (+) lead, a return (–) lead and a safety (green) wire. Verification shall be considered successful when the analysis shows the portable equipment/power cords contains a supply (+) lead, a return (–) lead and a safety (green) wire with one end connected to the portable equipment chassis (and all exposed conductive surfaces) and the other end connected to structure at the utility outlet. Use of double insulation or its equivalent without the safety (green) wire, when used as an alternative, shall be documented in the payload unique ICD as an exception.

B. Analysis of cables drawing assembly shall ensure non–battery powered portable equipment provide a redundant ground path terminated at the connector back shell. Verification shall be considered successful when the analysis shows the portable equipment contains a redundant ground that terminated at both ends of connector backshells and the sized to carry the fault load.

4.3.2.6 MPLM

NVR

4.3.2.6.1 MPLM ELECTRICAL POWER CHARACTERISTICS

The operation and compatibility of the integrated rack with MPLM Electrical Power Characteristics shall be verified by the Interface C verification requirements in the following paragraphs:

A. Paragraph 4.3.2.1.1.2

B. Paragraph 4.3.2.1.2.1

C. Paragraph 4.3.2.1.2.2

D. Paragraph 4.3.2.1.3.2

E. Paragraph 4.3.2.1.3.3

F. Paragraph 4.3.2.1.3.4

G. Paragraph 4.3.2.1.3.4

4.3.2.6.2 MPLM ELECTRICAL POWER INTERFACE

Integrated rack shall meet the electrical power interface verification requirements in the following paragraphs:

A. Paragraph 4.3.2.2.6.1.1, B

B. Paragraph 4.3.2.2.6.1.1, D

C. Paragraph 4.3.2.2.7.2

D. Paragraph 4.3.2.2.8

E. Paragraph 4.3.2.2.9, with the 12 amp LISN in Figure 3.2.2.9–1 used in the test setup.

F. Paragraph 4.3.2.2.10

4.3.2.6.2.1 MPLM UIP CONNECTORS AND PIN ASSIGNMENTS

A. NVR. Physical mating verification requirements are specified in paragraph 4.3.1.1.6.1.

B. Verification of appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P1 pinouts match the corresponding J1 pinouts. The verification shall be considered successful when the inspection shows that the P1 connector pinout is appropriate.

C. Verification of the P1 connector with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P1 connectors.

4.3.2.6.2.2 COMPATIBILITY WITH RPC SOFT START/STOP IN MPLM

Compatibility with RPC Soft Start/Stop in MPLM shall be verified by test.

Verification of compatibility with RPC soft start/stop performance characteristics shall be performed by test when the initial supply of power is provided to the equipment connected to the RPC(s). Input power to the integrated rack shall be delivered through a PRCU or equivalent. The integrated rack connected to interface C shall be operated with multiple load combinations at levels ranging from 0% to 100% of the rated load current.

The verification shall be considered successful when test shows the integrated rack can initialize operation and is compatible with the RPC soft start/stop characteristics shown in Figure 3.2.6.2.2–1, as specified in paragraph 3.2.6.2.2.

4.3.2.6.2.3 MPLM SURGE CURRENT

Surge Current shall be verified by test and analysis. Input power to the integrated rack should be representative of the ISS power environment. Verification of compatibility with Surge Current limits shall be performed by test at high, nominal, and low input voltage values as specified. The power source used to perform the test shall be capable of providing a range of power between 0 kW to 1.2 kW at 113–126 Vdc. The integrated rack shall be operated under selected loading conditions that envelope operational loading. The analysis shall be performed using test data from the above test. The analysis shall indicate that the integrated rack can operate and is compatible with the Interface C electrical power characteristics based on test data and the requirements specified in paragraph 3.2.6.2.3.

The verification shall be considered successful when test and analysis show under high, nominal and low voltage conditions the surge current is less than 9.8 A for an integrated rack at the high power location, or less than 5.3 A at the low power location, the maximum current rate of change shall not exceed the values defined in Figure 3.2.2.4–2, and the duration of the surge current shall not exceed 9 milliseconds.

4.3.2.6.2.4 MPLM REVERSE ENERGY/CURRENT

Reverse Energy/Current shall be verified by analysis.

Input power to the integrated rack should be representative of the ISS power environment.

Verification of compatibility with Reverse Energy/Current limits shall be performed by analysis at the input power level corresponding to the integrated rack design. The power source used to perform the analysis shall be capable of providing a range of power between 0 kW to 1.2 kW at 113–126 Vdc. The integrated Rack shall be analyzed under selected loading conditions that envelope operational loading.

The verification shall be considered successful when analysis shows that the reverse current from the integrated rack to the upstream power source does not exceed 0.9 Amps for all environmental conditions specified in this document when powered from a voltage source with characteristics specified in paragraphs 3.2.6.1 and with a source impedance of 0.1 ohm.

4.3.2.6.2.5 MPLM PAYLOAD TRIP RATINGS

The trip ratings shall be verified by analysis.

The verification shall be considered successful when the analysis shows that trip ratings of all protective devices in the integrated rack are coordinated with the upstream RPC current-limiting and trip characteristics so that a fault that causes the tripping of a downstream protective device will not also trip the upstream RPC.

4.3.2.6.3 MPLM ELECTRICAL POWER CONSUMER CONSTRAINTS

Electrical power consumer constraints shall be verified by the verification requirements in the following paragraphs:

A. Paragraph 4.3.2.3.1.B

B. Paragraph 4.3.2.3.1.C

C. Paragraph 4.3.2.3.2.A

D. Paragraph 4.3.2.3.3

4.3.2.6.4 MPLM ELECTROMAGNETIC COMPATIBILITY

The electromagnetic compatibility (EMC) requirements of an integrated rack in MPLM shall be verified by the verification requirements in the following paragraphs:

A. Paragraph 4.3.2.4.1, Electrical Grounding

B. Paragraph 4.3.2.4.2, Electrical Bonding

C. Paragraph 4.3.2.4.3, Cable/Wire Design and control requirements

D. Paragraph 4.3.2.4.4, Electromagnetic Interference

E. Paragraph 4.3.2.4.5, Electrostatic Discharge

F. Paragraph 4.3.2.4.6, Alternating Current (ac) Magnetic Fields

G. Paragraph 4.3.2.4.7, Direct Current (dc) Magnetic Fields

H. Paragraph 4.3.2.4.8, Corona

I. Paragraph 4.3.2.4.9, Lightning

J. Paragraph 4.3.2.4.10, EMI Susceptibility for Safety-Critical Circuits

4.3.2.6.4.1 MPLM BONDING

The bonding between an integrated rack and MPLM shall be verified by Analysis. The analysis shall be based on integrated rack qualification data, and design and analysis data. The verification shall be considered successful when the data shows the bonding between the integrated rack and MPLM meets the class R bonding requirements in accordance with SSP 30245, Space Station Electrical Bonding Requirements.

4.3.2.6.5 MPLM SAFETY REQUIREMENTS

The MPLM safety requirements shall be verified by the verification requirements in the following paragraphs:

A. Paragraph 4.3.2.5.1.1

B. Paragraph 4.3.2.5.1.2

C. Paragraph 4.3.2.5.2

D. Paragraph 4.3.2.5.3

E. Paragraph 4.3.2.5.4

F. Paragraph 4.3.2.5.5

4.3.3 COMMAND AND DATA HANDLING INTERFACE VERIFICATION REQUIREMENTS

4.3.3.1 GENERAL REQUIREMENTS

NVR

4.3.3.2 WORD/BYTE NOTATIONS, TYPES AND DATA TRANSMISSIONS

Information only, NVR

4.3.3.2.1 WORD/BYTE NOTATIONS

Verification of the word/byte notations shall be by inspection.

The inspection shall consist of a review of the word/byte notations against paragraph 3.1.1, Notations, of SSP 52050, and paragraph 3.1.1, Data Bit/Byte Numbering Convention, of SSP 57002.

Verification shall be considered successful when it is shown that the word/byte notations in the unique payload software ICD conforms with paragraph 3.1.1, Notations, of SSP 52050, and paragraph 3.1.1, Data Bit/Byte Numbering Convention, of SSP 57002.

4.3.3.2.2 DATA TYPES

Verification of the data types shall be by inspection.

The inspection shall consist of a review of the data types against paragraph 3.2.1 and subparagraphs, Data Formats, of SSP 50250.

Verification shall be considered successful when it is shown that the data types in the unique payload software ICD conforms with paragraph 3.2.1 and subparagraphs, Data Formats, of SSP 52050.

4.3.3.2.3 DATA TRANSMISSIONS

A. Verification of the Low Rate Data Link (LRDL) transmissions shall be by inspection. The inspection shall consist of a review of the LRDL data transmissions against paragraph 3.4, Non–Signal Data Coding Standards, of D684–10056–01. Verification shall be considered successful when it is shown that the word/byte notations in the unique payload software ICD conforms with paragraph 3.4, Non–Signal Data Coding Standards, of D684–10056–01.

B. Verification of the Medium Rate Data Link (MRDL) transmissions shall be by inspection. The inspection shall consist of a review of the MRDL data transmissions against paragraph 3.3.3.1, Transmission Order, of SSP 52050. Verification shall be considered successful when it is shown that the word/byte notations in the unique payload software ICD conforms with paragraph 3.3.3.1, Transmission Order, of SSP 52050.

C. Verification of the High Rate Data Link (HRDL) transmissions shall be by inspection. The inspection shall consist of a review of the HRDL data transmissions against paragraph 1.6, Bit Numbering Convention and Nomenclature, of CCSDS 701.0–B–2. Verification shall be considered successful when it is shown that the word/byte notations in the unique payload software ICD conforms with paragraph 1.6, Bit Numbering Convention and Nomenclature, of CCSDS 701.0–B–2.

4.3.3.3 DELETED

4.3.3.4 CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS

NVR

4.3.3.4.1 CCSDS DATA

Verification of the CCSDS data for 3.3.4.1.A, B, and C shall be by analysis or test.

The analysis shall consist of a review of the CCSDS data in the software design documentation. The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats.

Analysis shall be considered successful when it is shown that in the software design documentation the integrated rack data which is transmitted space to ground is either CCSDS data packets or bitstream and the integrated rack data which is transmitted ground to space or to the payload MDM is CCSDS data packets.

Test shall be considered successful when the PRCU correctly receives the CCSDS data.

4.3.3.4.1.1 CCSDS DATA PACKETS

Verification of the CCSDS data packet shall be by test.

The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats.

Test shall be considered successful when the PRCU correctly receives the CCSDS data packets.

4.3.3.4.1.1.1 CCSDS PRIMARY HEADER

Verification of the CCSDS primary header shall be by test.

The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats.

Test shall be considered successful when the PRCU correctly receives the CCSDS primary header.

4.3.3.4.1.1.2 CCSDS SECONDARY HEADER

Verification of the CCSDS secondary header shall be by test.

The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats.

Test shall be considered successful when the PRCU correctly receives the CCSDS secondary header.

4.3.3.4.1.2 CCSDS DATA FIELD

Verification of the CCSDS data field shall be by test.

The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats.

Test shall be considered successful when the PRCU correctly receives the CCSDS data field.

4.3.3.4.1.3 CCSDS DATA BITSTREAM

Verification of the CCSDS bitstream shall be by test.

The test shall consist of a transmission of a known set of bits and an inspection of the received data with the transmitted data.

Test shall be considered successful when the PRCU correctly receives the CCSDS bitstream.

4.3.3.4.1.4 CCSDS APPLICATION PROCESS IDENTIFICATION FIELD

NVR

4.3.3.4.2 CCSDS TIME CODES

NVR

4.3.3.4.2.1 CCSDS UNSEGMENTED TIME

Verification of the CCSDS unsegmented time shall be by test.

The test shall consist of a data transmission with the PRCU and inspection of the transmitted data against the SSP 52050 formats.

Verification shall be to test the integrated rack with the PRCU, for correct test CCSDS unsegmented time.

4.3.3.4.2.2 CCSDS SEGMENTED TIME

NVR

4.3.3.5 MIL-STD-1553B LRDL

Verification of the MIL–STD–1553B LRDL shall be by test.

The test shall consist of an integrated rack's Payload Bus Remote Terminal and RT Validation Test Set, provided by ISS, used in the performance of a complete RT Validation in accordance with MIL–HDBK–1553, Notice 1, Appendix A, RT Validation Test Plan, to verify the design.

The test shall be considered successful when the integrated rack's Payload Bus Remote Terminal meets the RT Validation test as specified.

4.3.3.5.1 MIL-STD-1553B PROTOCOL

NVR

4.3.3.5.1.1 STANDARD MESSAGES

Verification of the standard messages shall be by inspection and test.

The test shall consist of the PRCU transmitting and receiving standard messages with the integrated rack.

Test shall be considered successful when the PRCU correctly receives the standard messages.

4.3.3.5.1.2 COMMANDING

Verification of the commanding shall be by test.

The test shall consist of the PRCU issuing commands to the integrated rack.

Test shall be considered successful when the integrated rack correctly responds to the commands issued by the PRCU.

4.3.3.5.1.3 HEALTH AND STATUS DATA

Verification of the health and status data shall be by test.

A. The payload health and status data shall be tested during checkout with the Payload Rack Checkout Unit (PRCU), the Suitcase Test Environment for Payloads (STEP) or equivalent. The payload health and status data shall be transmitted into the PRCU, the STEP, or equivalent and logged. Subsequent inspection of the logged data shall verify that it exists as defined in the unique payload software ICD. The test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the health and status data as it is defined in the unique payload software ICD, and in a format that complies with Table 3.2.3.5–1, Health and Status Packet Format, of SSP 52050.

B. The payload health and status data shall be tested during checkout with the PRCU, the STEP or equivalent. The payload health and status data shall be transmitted into the PRCU, the STEP, or equivalent and logged. The test shall be considered successful when the PRCU, STEP, or equivalent correctly receives the health and status data at the rate defined in the unique payload software ICD, and in a format that complies with Table 3.2.3.5–1, Health and Status Packet Format, of SSP 52050.

C. The payload health and status data shall be tested during checkout with an MPLM MDM flight equivalent unit (FEU) hosted on an MDM Applications Test Environment (MATE) III or equivalent. The payload health and status data shall be transmitted into the MATE III or equivalent and logged. The test shall be considered when the MATE III or equivalent correctly receives the health and status data as it is defined in the unique payload software ICD, and in a format that complies with Table 3.2.3.5–1, Health and Status Packet Format, of SSP 52050.

D. The payload health and status data shall be tested during checkout with an MPLM MDM FEU hosted on an MATE III or equivalent. The payload health and status data shall be transmitted into the MATE III or equivalent and logged. The test shall be considered successful when the MATE III or equivalent correctly receives the health and status data as it is defined in the unique payload software ICD, and in a format that complies with Table 3.2.3.5–1, Health and Status Packet Format, of SSP 52050.

E. The payload health and status data shall be tested during checkout with an MPLM MDM FEU hosted on an MATE III or equivalent. The payload health and status data shall be transmitted into the MATE III or equivalent and logged. The test shall be considered successful when the MATE III or equivalent correctly receives the health and status data as it is defined in the unique payload software ICD, and in a format that complies with Table 3.2.3.5–1, Health and Status Packet Format, of SSP 52050.

4.3.3.5.1.4 SAFETY DATA

Verification of the safety data shall be by test and inspection.

A. The verification of safety data parameters contained within the payload Health and Status packet shall be by test and inspection. The test shall consist of a transmission of the payload generated Caution and Warning (C&W) related parameters to a PRCU or equivalent and confirmation that the correct number of words were received as documented in Table A–5 of the payload unique software ICD. Inspection shall consist of a comparison of the received parameters against the format defined in paragraph 3.2.3.5 of SSP 52050, and Table A–1 and Table A–5 of the payload unique software ICD.

If the PSRP has not identified any safety data parameters, then this requirement verification is not applicable.

Inspection and test shall be considered successful when there is a one–to–one correlation between the safety data received by the PRCU or equivalent and the data defined by the payload unique software ICD.

B. The verification of safety data contained within the C&W status message shall be by test and inspection. The test shall consist of a transmission of a Class 2, Class 3, and Class 4 C&W message to a PRCU or equivalent and confirmation that the correct number of words were received as documented in Table A–5 of the payload unique software ICD. Inspection shall consist of a comparison of the received data against the format defined in paragraph 3.2.3.5 of SSP 52050, and Table A–1 and Table A–5 of the payload unique software ICD.

If the PSRP has not identified any safety parameters, and the Payload Developer has not identified any payload C&W status messages then no generation of C&W messages is required.

Inspection and test shall be considered successful when there is a one–to–one correlation between the C&W data received by the PRCU or equivalent and the data defined by the payload unique software ICD.

4.3.3.5.1.4.1 CAUTION AND WARNING

NVR

4.3.3.5.1.4.1.1 CLASS 1 – EMERGENCY

NVR

4.3.3.5.1.4.1.2 CLASS 2 – WARNING

Verification that the integrated rack formats the C&W word for the listed warning events shall be by analysis and test.

Analysis of the payload safety hazard reports and payload safety review data shall identify the types of events identified as warnings that are being monitored.

The test shall use the STEP, PRCU or equivalent to determine whether or not the C&W word in the integrated rack's health and status is formatted as a warning for the events identified as warnings.

Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as a warning for events that are defined as a warning.

4.3.3.5.1.4.1.3 CLASS 3 – CAUTION

Verification that the integrated rack formats the C&W word for the listed caution events shall be by analysis and test.

Analysis of the payload safety hazard reports and payload safety review data shall identify the types of events identified as cautions that are being monitored.

The test shall use the STEP, PRCU or equivalent to determine whether or not the C&W word in the integrated rack's health and status is formatted as a caution for the events identified as cautions.

Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as a caution for events that are defined as a caution.

4.3.3.5.1.4.1.4 CLASS 4 – ADVISORY

Verification that integrated racks requiring advisories format the C&W word for the listed advisory events shall be by analysis and test.

Analysis of proposed payload advisories shall identify the types of events identified as advisories.

The test shall use the STEP, PRCU or equivalent to determine whether or not the C&W word in the integrated rack's health and status is formatted as an advisory for the events identified as advisories.

Verification shall be considered successful when the analysis shows the C&W word is formatted in accordance with paragraph 3.2.3.5, Health and Status Data, of SSP 52050 as a advisory for events that are defined as an advisory.

4.3.3.5.1.5 SERVICE REQUESTS

Verification of the service requests shall be by test.

The test shall consist of the reception of the integrated rack's service request by the PRCU.

Verification shall be to test the integrated rack with the PRCU, for correct test service requests.

4.3.3.5.1.6 ANCILLARY DATA

NVR

4.3.3.5.1.7 FILE TRANSFER

Verification of the file transfer data for those payloads requiring file transfer shall be by test.

The test shall consist of a test for both the request to transfer and the actual transfer of a file with the PRCU. The transmitted file shall be inspected against the received file.

Verification shall be to test the integrated rack with the PRCU, for correct test file transfer.

4.3.3.5.1.8 LOW RATE TELEMETRY

Verification of the low rate telemetry data for those payloads requiring low rate telemetry shall be by test.

The test shall consist of a test of both the request to transmit and the transmission of low rate telemetry with the PRCU. The transmitted low rate telemetry shall be inspected against the received low rate telemetry.

Verification shall be to test the integrated rack with the PRCU, for correct low rate telemetry.

4.3.3.5.1.9 DEFINED MODE CODES

NVR

4.3.3.5.1.10 IMPLEMENTED MODE CODES

Verification of the implemented mode codes shall be by test.

The test shall consist of the reception by the test equipment of the integrated rack's Payload Bus Remote Terminal's response to an implemented mode code transmitted by the test equipment.

Test shall be considered successful when the integrated rack's Payload Bus Remote Terminal correctly responds to the implemented mode codes in a RT validation test as defined in MIL–HDBK–1553, Notice 1, Appendix A, RT Validation Test Plan.

4.3.3.5.1.11 UNIMPLEMENTED/UNDEFINED MODE CODES

If a RT is designed to monitor for unimplemented and undefined modes codes,verification of the unimplemented and undefined mode codes shall be test.

The test shall consist of the reception by the test equipment of the integrated rack's Payload Bus Remote Terminal's response to an unimplemented/undefined mode code transmitted by the test equipment.

Verification shall be to test that the integrated rack's Payload Bus Remote Terminal correctly responds to the unimplemented and undefined mode codes produce by setting the message error bit in the status word response in a RT validation test as defined in MIL–HDBK–1553, Notice 1, Appendix A, RT Validation Test Plan.

4.3.3.5.1.12 ILLEGAL COMMANDS

If a RT is designed to monitor for illegal commands, verification of the illegal commands shall be by test.

Verification shall be to test that the integrated rack's Payload Bus Remote Terminal correctly responds to the illegal commands by setting the message error bit in the status word response in a RT validation test as defined in MIL–HDBK–1553, Notice 1, Appendix A, RT Validation Test Plan.

Verification shall be considered successful when the integrated rack's Payload Bus Remote Terminal sets the message error bit when the test equipment sends an illegal command.

4.3.3.5.2 MIL–STD–1553B LRDL INTERFACE CHARACTERISTICS

NVR

4.3.3.5.2.1 LRDL REMOTE TERMINAL ASSIGNMENT

NVR

4.3.3.5.2.1.1 LRDL CONNECTOR/PIN ASSIGNMENTS

NVR

4.3.3.5.2.1.2 MIL–STD–1553B BUS A AND B CONNECTOR/PIN ASSIGNMENT

Verification of the MIL–STD–1553B bus A connector and pin assignment shall be by inspection and test.

A. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

B. Verification of P3 and P4 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P3 and P4 pinout matches the corresponding UIP J3 and J4 pinout respectively. The verification shall be considered successful when the inspection shows that the P3 and P4 connector pinout is appropriate.

C. Verification of the P3 and P4 connector with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P3 and P4 connectors.

Verification shall be to test the integrated rack with the PRCU, for correct test of the MIL–STD–1553B to receive and execute commands on P3 and P4 independently with various address assignments at P3 and P4.

4.3.3.5.2.1.3 DELETED

4.3.3.5.2.1.4 REMOTE TERMINAL HARDWIRED ADDRESS CODING

A. Unique RT addressing shall be verified by test. The RT validation test performed for LRDL verification per section 4.3.3.5 shall be sufficient to demonstrate that the RT responds to each assigned RT hardwired address for all of the ISPR locations. The test shall be considered successful when the RT validation test per section 4.3.3.5 is correctly completed.

B. Verification that decimal values are mapped in 5 bit representation, bit 0 = Least Significant Bit (LSB), shall be verified by inspection. Inspection shall be considered successful when a review of payload and/or component documentation shows that the RT address conforms with 3.3.5.2.1.4.B.

C. Odd–parity shall be used and shall be verified by test. The RT validation test performed for LRDL verification per section 4.3.3.5 shall be sufficient to demonstrate that the RT does not respond to an RT address with even parity. The test shall be considered successful when the RT validation test per section 4.3.3.5 is correctly completed.

D. Verification that address line jumpers to ground are tied to logic 0 shall be verified by inspection. Inspection shall be considered successful when a review of payload and/or component documentation shows that the appropriate RT address lines are tied to logic 0 per 3.3.5.2.1.4.D.

4.3.3.5.2.2 LRDL SIGNAL CHARACTERISTICS

Verification of the Terminal Characteristics shall be by test of the MIL–STD–1553B bus A and bus B. The test shall consist of measurement of the LRDL signal characteristics with the RT Validation Test Set per MIL–HDBK–1553A section 100 or appendix A of MIL–HDBK–1553 Notice 1, including exceptions documented in SSP 50342. Verification shall be considered successful when the Remote Terminal meets all conditions of section 4.5.2, Terminal Characteristics of MIL–STD–1553B, Notice 2.

4.3.3.5.2.3 LRDL CABLING

A. Verification shall be by inspection of the integrated rack LRDL cable. The inspection shall show the LRDL cable meets the requirements of SSQ 21655, Cable, Electrical, MIL–STD–1553B Data Bus, Space Quality, General Specifications for 75 Ohm or Equivalent.

B. Verification shall be by inspection that the integrated rack internal wiring stub length does not exceed 12 feet, (3.65 meters).

4.3.3.5.2.4 MULTI–BUS ISOLATION

If an integrated rack’s Payload Bus RT utilizes multiple ISS Payload MIL–STD–1553B data buses, verification of the isolation between the various ISS Payload MIL–STD–1553B data buses shall be by test.

The test shall consist of the measurement of the signal isolation between the multiple ISS Payload MIL–STD–1553B data buses of the integrated rack’s Payload Bus Remote Terminal in a RT validation test as defined in MIL–HDBK–1553, Notice 1, Appendix A, RT Validation Test Plan.

Verification shall be considered successful when the measurement of the signal isolation between the integrated rack's Payload Bus Remote Terminal's multiple ISS Payload MIL–STD–1553B data buses is no less than 58 dB.

4.3.3.6 MEDIUM RATE DATA LINK (MRDL)

NVR

4.3.3.6.1 MRDL PROTOCOL

Verification of the MRDL LAN 1 and LAN 2 shall be by inspection and test.

Verification shall be by inspection of the integrated rack MRDL protocol to the unique integrated rack software ICD against SSP 52050 and SSP 57002.

Verification shall be to test the integrated rack with the PRCU, for correct test of the MRDL protocol per the ISO/IEC 8802–3 for 10 Base T, using an Ethernet network analyzer.

4.3.3.6.1.1 INTEGRATED RACK PROTOCOLS ON THE MRDL

Verification of the integrated rack protocols length and format on the MRDL LAN 1 and LAN 2 shall be by inspection and test.

Verification shall be by inspection of the integrated rack MRDL protocol to the unique integrated rack software ICD against SSP 52050 and SSP 57002.

Verification shall be to test the integrated rack with the PRCU, for correct test of the MRDL protocol per the ISO/IEC 8802–3 for 10 Base T, using an Ethernet network analyzer.

4.3.3.6.1.2 MRDL ADDRESS

A. Verification of the integrated rack MRDL LAN 1 and LAN 2 unique address shall be by analysis and test.

   Verification shall be by analysis. The analysis shall verify that the unique numbers were issued by IEEE or their representative. Verification shall be considered successful when traceability of addresses to IEEE has been shown.

   The test shall verify that the integrated rack correctly implements the Ethernet protocol with the PRCU or equivalent. The verification shall be considered successful when the protocol meets the requirements of ISO/IEC 8802–3 for 10 Base T, using an Ethernet network analyzer.

B. Verification of the sub rack or nonrack payloads internal MRDL LAN unique address shall be by analysis and test.

The analysis shall verify that the unique numbers were issued by IEEE or their representative. Verification shall be considered successful when traceability of addresses to IEEE has been shown.

The test shall verify that the sub rack or nonrack payloads correctly implements the Ethernet protocol with Ethernet network analyzer. The verification shall be considered successful when the protocol meets the requirements of ISO/IEC 8802–3 for 10 Base T, using an Ethernet network analyzer.

C. Verification that the MAC address is set prior to the Ethernet terminal going active shall be by test.

The test shall verify that the integrated rack, sub rack, or nonrack payloads correctly implements the Ethernet protocol with Ethernet network analyzer. The verification shall be considered successful when the protocol meets the requirements of ISO/IEC 8802–3 for 10 Base T, using an Ethernet network analyzer. This test may be combined with tests for A or B.

4.3.3.6.1.3 ISPR MRDL CONNECTIVITY

A. Verification of the integrated rack MRDL connectivity shall be by inspection. Inspection shall be considered successful when it is shown that the integrated rack drawings in the unique hardware ICD conform to section 3.3.3.1, Connectors, of SSP 57001.

B. Verification of MRDL data routing shall be by test. The test shall be accomplished with the PRCU or equivalent. The test shall be considered successful when it is shown that MRDL data can be successfully routed to the proper ISS LAN with the correct MRDL address.

C. For integrated racks with an internal MRDL, verification shall be by test. The test shall be accomplished with the PRCU or equivalent. The test shall be considered successful when it is shown that isolation exists between the integrated rack internal LAN and the ISS LAN.

4.3.3.6.1.4 MRDL CONNECTOR/PIN ASSIGNMENTS

Verification of the MRDL connector and pin assignment shall be by inspection.

A. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

B. Verification of P46 and P47 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P46 and P47 pinout matches the corresponding J46 and J47 pinout. The verification shall be considered successful when the inspection shows that the P46 and P47 connector pinout is appropriate.

C. Verification of the P46 and P47 connectors with the requirements of SSQ 21635 and shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P46 and P47 connectors.

4.3.3.6.1.5 MRDL SIGNAL CHARACTERISTICS

Verification of the MRDL LAN–1 and LAN–2 signal characteristics shall be by inspection and test.

Verification shall be by inspection of the integrated rack MRDL protocol to the unique integrated rack hardware ICD against SSP 57001.

Verification shall be to test the integrated rack with the PRCU, for correct test of the MRDL signal requirements per the ISO/IEC 8802–3 for 10 Base T, using an Ethernet network analyzer.

4.3.3.6.1.6 MRDL CABLE CHARACTERISTICS

Verification shall be by inspection of the integrated rack MRDL cable.

Verification shall be considered successful when it is shown that the integrated rack MRDL cable meets SSQ 21655, 100 ohm or equivalent.

4.3.3.7 HIGH RATE DATA LINK (HRDL) (TBR #15) (TBR #16)

NVR

4.3.3.7.1 PAYLOAD HRFM PROTOCOLS

Verification of the HRDL shall be by test and inspection.

The test shall consist of a transmission of the payload HRDL data to the PRCU or equivalent and confirmation that the correct number of words were received as documented in Table A–11 and Table A–12 of the payload unique software ICD.

Verification by inspection shall consist of a comparison of the received data against the format defined in the payload unique software ICD.

Verification shall be considered successful when the correct number of words and correct format is received by the PRCU or equivalent per the payload unique software ICD.

4.3.3.7.1.1 CCSDS PACKET PROTOCOL

NVR

4.3.3.7.1.1.1 PACKET DATA FRAMES

Verification of packet data frames shall be by test and inspection.

Verification shall be to test the integrated rack with the PRCU.

Verification shall be by inspection of the integrated rack HRDL protocol against sections 3.3.3.1.1, 3.3.3.1.1.1, and 3.3.3.1.1.2 of SSP 50184. Verification shall be considered successful when it is shown that the packet data frames comply with the requirements of SSP 50184.

4.3.3.7.1.1.2 PACKET DATA RATES

Verification of packet data rates shall be by test and inspection.

Verification shall be to test the integrated rack with a TAXI Analyzer or a flight equivalent HRFM, as negotiated with PEI.

Verification shall be by inspection of the integrated rack HRDL protocol against sections 3.3.3.1.2, 3.3.3.1.2.1, 3.3.3.1.2.2, 3.3.3.1.2.2.1, and 3.3.3.1.2.2.2 of SSP 50184. Verification shall be considered successful when it is shown that the data rates comply with the requirements of SSP 50184.

NOTE: There is a risk when using the HRFM test that all data configurations have not been tested and packet loss may occur when that configuration is used on orbit. The packet data rate should follow the structure provided in SSP 50184. If this structure is not followed, there is a possibility that data could be lost. PDs will have to accept the risk if this verification method is used.

4.3.3.7.1.1.3 PACKET FORMAT

Verification of packet format shall be by test and inspection.

Verification shall be to test the integrated rack with the PRCU.

Verification shall be by inspection of the integrated rack HRDL protocol against sections 3.3.3.1.3.1 and 3.3.3.1.3.2 of SSP 50184. Verification shall be considered successful when it is shown that the packet format complies with the requirements of SSP 50184.

4.3.3.7.1.2 BITSTREAM PROTOCOL

NVR

4.3.3.7.1.2.1 DATA FRAMES

Verification of data frames shall be by test and inspection.

Verification shall be to test the integrated rack with a TAXI Analyzer or a flight equivalent HRFM, as negotiated with PEI.

Verification shall be by inspection of the integrated rack HRDL protocol against sections 3.3.3.2.1.1 and 3.3.3.2.1.2 of SSP 50184. Verification shall be considered successful when it is shown that the data frames comply with the requirements of SSP 50184.

NOTE: There is a risk when using the HRFM test that all data configurations have not been tested and packet loss may occur when that configuration is used on orbit. The data frame should follow the structure provided in SSP 50184. If this structure is not followed, there is a possibility that data could be lost. PDs will have to accept the risk if this verification method is used.

4.3.3.7.1.2.2 DATA RATES

Verification of data rates shall be by test and inspection.

Verification shall be to test the integrated rack with a TAXI Analyzer or a flight equivalent HRFM, as negotiated with PEI.

Verification shall be by inspection of the integrated rack HRDL protocol against sections 3.3.3.2.2, 3.3.3.2.2.1, 3.3.3.2.2.2, and 3.3.3.2.2.2.1 of SSP 50184. Verification shall be considered successful when it is shown that the data rates comply with the requirements of SSP 50184.

NOTE: There is a risk when using the HRFM test that all data configurations have not been tested and packet loss may occur when that configuration is used on orbit. The data rate should follow the structure provided in SSP 50184. If this structure is not followed, there is a possibility that data could be lost. PDs will have to accept the risk if this verification method is used.

4.3.3.7.2 HRDL INTERFACE CHARACTERISTICS

NVR

4.3.3.7.2.1 PHYSICAL SIGNALING

Verification of the HRDL physical signaling shall be by test and analysis.

Verification of the fiber optic transmitted waveform at the fiber optic transmitter component shall be by test. This test may be conducted at fiber optic component subassembly.

Verification of the integrated rack fiber optic transmitted waveform shall be by analysis.

Verification of the fiber optic receiver fiber optic sensitivity and bit error rate (BER) shall be by test of the fiber optic receiver component.

Verification of the BER (per ANSI X3.255 test) and the integrated rack fiber optic receiver sensitivity shall be by test.

Verification by test and analysis shall be considered successful when the results meet the applicable requirements in sections 3.1.1, 3.1.2, and 3.1.3 of SSP 50184 and the BER test section in ANSI X3.255.

4.3.3.7.2.1.1 PHYSICAL SIGNALING DATE RATES

Verification of HRDL physical signaling shall be by test.

A. DELETED

B. Verification of the payload data rates is by test and is considered successful when the HRDL data rate is less than or equal to the integrated rack assigned data rate. All selectable data rates are to be recorded.

C. NVR

4.3.3.7.2.2 ENCODING

Verification of the HRDL encoding shall be by test.

Verification shall be to test the integrated rack with the PRCU.

Verification shall be considered successful when it is shown that encoding complies with section 3.1.3 of SSP 50184.

4.3.3.7.3 INTEGRATED RACK HRDL OPTICAL POWER

NVR

4.3.3.7.3.1 INTEGRATED RACK HRDL TRANSMITTED OPTICAL POWER

Verification shall be to test the integrated rack with fiber optic power meter per ANSI X3.255, for correct optical power using the Halt symbol. The optical power perturbations from the test setup are not included in the stated power requirement. The perturbations from the test are to be documented. This test shall be considered successful when the requirement is met or exceeded after the test setup variations are removed from the result.

4.3.3.7.3.2 INTEGRATED RACK HRDL RECEIVED OPTICAL POWER

Verification shall be to test the integrated rack with a calibrated fiber optic source using the Halt symbol at the minimum power. The optical power perturbations from the test setup are not included in the stated power requirement. The perturbations from the test are to be documented. This test shall be considered successful when the requirement is met or exceeded after the test setup variations are removed from the result.

4.3.3.7.4 HRDL FIBER OPTIC CABLE

Verification shall be by inspection of the integrated rack HRDL cable.

Verification shall be considered successful when it is shown that the integrated rack HRDL cable meets SSQ 21654 or equivalent.

4.3.3.7.5 HRDL FIBER OPTIC CABLE BEND RADIUS

Verification shall be by inspection of the integrated rack HRDL cable routing, installation and handling procedures.

Verification shall be considered successful when the inspection shows that the routing, installation and handling procedures don not cause the cable to be bent in a tighter radius, as specified in section 3.3.7.5 of SSP 57000.

4.3.3.7.6 HRDL CONNECTORS AND FIBER

A. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

B. Verification of P7 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P7 pinout matches the corresponding J7 pinout. The verification shall be considered successful when the inspection shows that the P7 connector pinout is appropriate.

C. Verification that the P7 connector meets the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P7 connector.

D. Verification that the HRDL fiber meets the requirements of SSQ 21654 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21654 requirement is identified on the drawing for the HRDL fiber.

4.3.3.7.7 DELETED

4.3.3.7.8 HRDL STATE

Verification of HRDL State shall be by analysis of the Lock–On State and Data Send State based on software/hardware algorithms.

Verification shall be considered successful when it is shown that the HRDL State has met the criteria within sections 3.3.1.1.2 and 3.3.1.1.3 of SSP 50184.

4.3.3.8 PERSONAL COMPUTERS

NVR

4.3.3.8.1 PAYLOAD LAPTOP

A. Verification shall be by inspection. The inspection shall be of the procurement documentation from a vendor qualified to deliver laptops in accordance with JSC 27337. Verification shall be considered successful when is it shown that the payload laptop was procured from a qualified vendor (e.g. JSC PCS Project)

B. Verification shall be by inspection. An inspection of the Payload Laptop software load shall be performed to verify compliance with the requirement. Verification shall be considered successful when the inspection shows that the laptop is utilizing the Windows NT 4.0 server software load with services and applications as specified in 3.3.8.1.B

C. Payload Laptop displays shall be verified by demonstration. The demonstration shall be performed on the flight hardware. Verification shall be considered successful when the demonstration to the Payload Display Review Panel (PDRP) shows the requirements in SSP 50313 have been met.

D. Verification shall be by inspection. The inspection shall be of flight drawings or hardware. The verification shall be considered successful when the inspection shows that each rack has no more than one Payload Laptop.

E. Verification shall be by inspection. An inspection of flight drawings shall be performed to verify compliance with the requirements. The verification shall be considered successful when the inspection shows the connector requirements have been met.

F. Verification shall be by inspection. An inspection of flight drawings shall be performed to verify compliance with the requirement. The verification shall be considered successful when the inspection shows the cable design requirements have been met.

G. Verification shall be by inspection. An inspection of flight drawings shall be performed to verify compliance with the requirement. The verification shall be considered successful when the inspection shows the converter requirement has been met.

H. Verification shall be by inspection. An inspection of flight drawings shall be performed to verify compliance with the requirement. The verification shall be considered successful when the inspection shows the equipment is as specified.

4.3.3.8.2 PCS

A. Verification of requirements shall be by test. Software testing shall be performed by PSIV per CEA (Customer Expectation Agreement) PCS–PSIV–01. Verification shall be considered successful when PSIV software testing shows that the requirements in SSP 52052 have been met.

B. PCS displays shall be verified by demonstration. Verification shall be considered successful when the demonstration to the PDRP shows that the requirements in SSP 50313 have been met.

C. Verification shall be by inspection. The inspection shall be of flight drawings or hardware. The verification shall be considered successful when the inspection shows that each rack uses no more than one PCS.

4.3.3.8.2.1 PCS TO UOP INTERFACE

A. NVR

B. NVR

4.3.3.8.2.2 760XD LAPTOP TO RACK INTERFACE

A. Verification shall be by inspection. An inspection of flight drawings shall be performed to verify compliance with the requirements. The verification shall be considered successful when the inspection shows the connector requirements have been met.

B. Verification shall be by inspection. An inspection of flight drawings shall be performed to verify compliance with the requirement. The verification shall be considered successful when the inspection shows the cable requirements have been met.

C. Verification shall be by inspection. An inspection of flight drawings shall be performed to verify compliance with the requirement. The verification shall be considered successful when the inspection shows the converter requirement has been met.

D. Verification shall be by inspection. An inspection of flight drawings shall be performed to verify compliance with the requirement. The verification shall be considered successful when the inspection shows the equipment is as specified.

4.3.3.8.3 SSC

A. Verification shall be by inspection. The inspection shall be of flight drawings or hardware. The verification shall be considered successful when the inspection shows that each rack uses no more then one SSC.

B. SSC displays shall be verified by demonstration. The demonstration shall be performed on the flight hardware. Verification shall be considered successful when the demonstration to the Payload Display Review Panel (PDRP) shows the requirements in SSP 50313 have been met.

4.3.3.9 UOP

NVR

4.3.3.10 MAINTENANCE SWITCH, SMOKE DETECTOR, SMOKE INDICATOR, AND INTEGRATED RACK FAN INTERFACES

NVR

4.3.3.10.1 RACK MAINTENANCE SWITCH (RACK POWER SWITCH) INTERFACES

Verification for correct operation of the rack maintenance switch shall be by test, with the use of the PRCU or equivalent. The test shall be considered successful when the signal characteristics comply with Table 3.3.10.1–1.

4.3.3.10.2 SMOKE DETECTOR INTERFACES

Verification of the smoke detector interface shall be by inspection.

Verification shall be by inspection of the smoke detector interfaces are powered from the integrated rack to the unique integrated rack hardware ICD against and SSP 57001.

4.3.3.10.2.1 ANALOG INTERFACE CHARACTERISTICS

Verification of the analog interface characteristics shall be by inspection.

Verification shall be by inspection of the analog interface characteristics to the unique integrated rack hardware ICD against and SSP 57001.

4.3.3.10.2.2 DISCRETE COMMAND BUILT-IN-TEST INTERFACE CHARACTERISTICS

Verification of the discrete command BIT interface characteristics shall be by inspection.

Verification shall be by inspection of the discrete command BIT interface characteristics to the unique integrated rack hardware ICD against and SSP 57001.

4.3.3.10.2.3 SMOKE INDICATOR ELECTRICAL INTERFACES

Verification of the smoke indicator electrical interface shall be by analysis and test.

Verification shall be by analysis of the discrete components and circuit for the interface characteristics.

Verification of function shall be to test the integrated rack with the PRCU, for function of the smoke indicator on P43. No test on the luminance of the indicator is required.

Verification of the smoke indicator electrical interface capacitance shall be by analysis.

The verification shall be considered successful when the calculation of total capacitance of the “Smoke Indicator” LED on the schematics, drawings or specifications is less than the maximum capacitance value in Table 3.3.10.2.3–1.

Note: The following is an example of analysis:

For racks using the Rack Power Switch Assembly (683–50370), the analysis below is for dash three and five, as shown in Figure 4.3.3.10.2.3–1.

- The maximum capacitance is verified by analysis of the specification data. The total capacitance will not exceed the sum of the zener part and the LED part.
  - The LED part number 683–29448–2 has a maximum capacitance of less than 100 pico–farad.
  - The Zener part number JANTXV1N6331 has a maximum capacitance of 275 pico–farad.
  - The Resistor part number is RER60F6340R.
- The worst case maximum capacitance of 375 pico–farad produced in the Rack Power Switch Assembly (683–50370) is below the 2 nF (2000 pico–farad) requirement.

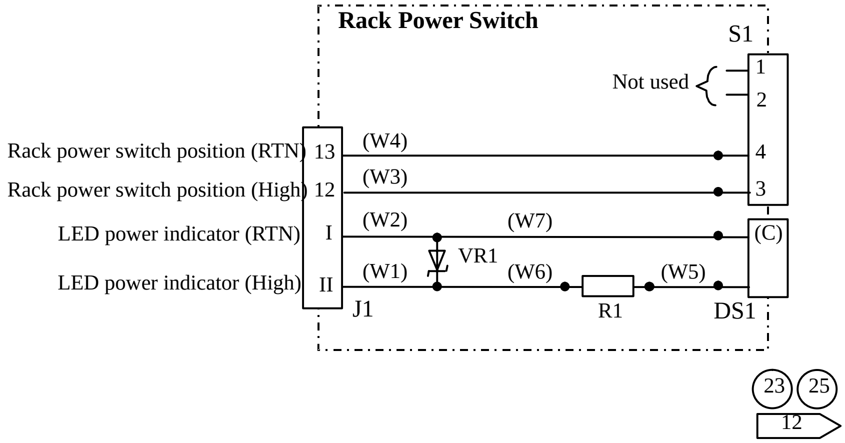


FIGURE 4.3.3.10.2.3–1 CONNECTION DIAGRAM FOR –3 AND –5 ASSEMBLY

4.3.3.10.2.4 FAN VENTILATION STATUS ELECTRICAL INTERFACES

Verification of the discrete command BIT interface characteristics shall be by inspection.

Verification shall be by inspection of the discrete command BIT interface characteristics to the unique integrated rack hardware ICD against and SSP 57001.

4.3.3.10.3 RACK MAINTENANCE SWITCH (RACK POWER SWITCH)/FIRE DETECTION SUPPORT INTERFACE CONNECTOR

Verification of the rack maintenance switch/fire detection support interface (maintenance) connector shall be by inspection.

Verification shall be by inspection of the integrated rack maintenance connector to mate with a test connector SSQ 21635, NATC07T13N35SA.

A. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.

B. Verification of P43 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P43 pinout matches the corresponding J43 pinout. The verification shall be considered successful when the inspection shows that the P43 connector pinout is appropriate.

C. Verification of the P43 connector with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P43 connector.

4.3.4 PAYLOAD NTSC VIDEO AND AUDIO INTERFACE REQUIREMENTS

NVR

4.3.4.1 PAYLOAD NTSC VIDEO INTERFACE REQUIREMENTS

4.3.4.1.1 PAYLOAD NTSC OPTICAL VIDEO SIGNAL CHARACTERISTICS

Verification shall be to test the integrated rack with the PRCU or equivalent in accordance with Table 3.4.1.1–1. The verification shall be considered successful when the test demonstrates that the received video signal complies with Table 3.4.1.1–1.

4.3.4.1.2 NTSC FIBER OPTIC VIDEO

NVR

4.3.4.1.2.1 PAYLOAD NTSC VIDEO CHARACTERISTICS

Verification shall be to test the integrated rack with a video test system in accordance with EIA/TIA–250–C, End to End NTSC Video for Satellite Transmission System per the paragraphs specified in Table 1, NTSC Video Performance Characteristics while receiving the PFM NTSC Fiber Optic Video Characteristics and Table 3.4.1.2–1, NTSC Fiber Optic Video Characteristics.

4.3.4.1.2.2 INTEGRATED RACK NTSC PFM VIDEO TRANSMITTED OPTICAL POWER

Verification shall be to test the integrated rack with fiber optic power meter. The perturbations optical power from the test setup are not included in the stated power requirement. The perturbations from the test are to be documented. This test shall be considered successful when when the requirement is met or exceeded after the test setup variations are removed from the result.

4.3.4.1.2.3 INTEGRATED RACK NTSC PFM VIDEO AND SYNC SIGNAL RECEIVED OPTICAL POWER

Verification shall be to test the integrated rack with a calibrated fiber optic source testing at the minimum power. The perturbations optical power from the test setup are not included in the stated power requirement. The perturbations from the test are to be documented. This test shall be considered successful when the requirement is met or exceeded after the test setup variations are removed from the result.

4.3.4.1.2.4 NTSC ELECTRICAL VIDEO CHARACTERISTICS

Verification shall be by inspection of the integrated rack fiber optic video cable. Verification shall be considered successful when it is shown that the integrated rack fiber optic video cable meets 3.4.1.2.5, Optical Video Fiber Characteristics.

4.3.4.1.2.5 PFM NTSC VIDEO FIBER OPTIC CABLE BEND RADIUS

Verification shall be by inspection of the integrated rack PFM NTSC video fiber optic cable routing, installation and handling procedures.

Verification shall be considered successful when the inspection shows that the routing, installation and handling procedures don not cause the cable to be bent in a tighter radius.

4.3.4.1.2.6 DELETED

4.3.4.1.2.7 PFM NTSC OPTICAL CONNECTOR/PIN ASSIGNMENTS

A. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

B. Verification of P16 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P16 pinout matches the corresponding J16 pinout. The verification shall be considered successful when the inspection shows that the P16 connector pinout is appropriate.

C. Verification of the P16 connector with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P16 connector.

4.3.4.1.3 NTSC ELECTRICAL VIDEO INTERFACES

4.3.4.1.3.1 CABLES

Verification of the cables required for transmission of sync and control signals and video and status signals shall be by inspection of the flight drawings. Verification shall be considered successful when the inspection shows that the cable meets the requirements of SSQ 21655; NDBC–TFE–22–2SJ–75.

4.3.4.1.3.2 SIGNAL STANDARD

Verification of the integrated rack’s ability to send and receive video, status, and sync signals shall be by test. The signal degradation from Out–Put video to In–Put video can be simulated by using a 60 meter long SSQ 21655; NDBC–TFE–22–25J–75 cable. A test shall be performed using the PRCU or equivalent to verify that ISPR input/output video, status, and sync signals are in accordance with RS–170A at the UIP interface as defined in Figure 3.4.1.3.2–1, Interface B.

4.3.4.1.3.3 INTERFACE CIRCUIT

Verification of interface circuit of video system component in the ISPR for sync, video output and video input shall be by analysis. The analysis shall show that the input load impedance of the receive circuit to cable is greater than 6 K ohms measured from signal to ground while the circuit is active, and voltage in the circuit shall not exceed the tolerance limits of +/– 5.5 V. The verification shall be considered successful when the analysis shows that the video system interface circuit complies with Figure 3.4.1.3.3–1.

4.3.4.1.3.4 CROSS TALK

Verification of cross talk shall be by test. The test shall use NTC–7 method and record the actual cross talk value in dB. Verification shall be considered successful when the test value is less than the requirement.

4.3.4.1.4 NTSC ELECTRICAL CONNECTOR/PIN ASSIGNMENTS

A. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

B. Verification of P77 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P77 pinout matches the corresponding J77 pinout. The verification shall be considered successful when the inspection shows that the P77 connector pinout is appropriate.

C. Verification of the P77 connector with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P77 connector.

4.3.4.2 U.S. ELEMENT AUDIO INTERFACE REQUIREMENTS

NVR

4.3.5 THERMAL CONTROL INTERFACE REQUIREMENTS

4.3.5.1 INTERNAL THERMAL CONTROL SYSTEM (ITCS) INTERFACE REQUIREMENTS

4.3.5.1.1 PHYSICAL INTERFACE

A. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

B. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.5.1.2 ITCS FLUID CHARGING AND EXPANSION

A. Deleted

B. Verification that the integrated rack, non–rack payload, and ORU is fully charged with ITCS fluid shall be performed by test during final fluid filling of the integrated rack, non–rack payload and ORU. Final fluid filling of the integrated rack, non–rack payload and ORU shall be performed by evacuating the payload to 0.5 torr (67 Pa) or less prior to introduction of the fluid charge. The verification shall be considered successful when the test demonstrates the integrated rack and ORU can maintain less than 0.5 torr (67 Pa) for five minutes with the vacuum source isolated (vacuum decay check). Final fluid fill shall be initiated immediately after the successful vacuum decay check. The ITSC fluid in the integrated rack shall be circulated with the PRCU, or GSE with equivalent gas bubble removal capability, for 72 hours after the vacuum filling is complete.

   Note: Final integrated rack, non–rack payload or ORU coolant charging may be performed at KSC if the Payload Developer submits an Operations and Maintenance Requirements and Specification Document (OMRSD) via the Payload Data Library (PDL) KSC Technical Requirements Data Sets (TRDS).

C. Verification that the integrated rack, non–rack payload or ORU has the capability to account for thermal expansion of ITCS fluid over the specified temperature range when disconnected from the ITCS shall be by inspection and analysis. The verification shall be considered successful when the inspection and analysis shows that the thermal expansion compensation capability is capable of compensating for thermal expansion of the integrated rack's cooling fluid over the specified temperature range using the specified fill temperature during launch and landing.

D. Verification that the integrated rack, non–rack payload or ORU has the capability to account for thermal expansion of ITCS fluid over the specified temperature range when disconnected from ITCS shall be by inspection and analysis. The verification shall be considered successful when the inspection and analysis shows that the thermal expansion capability is present in the design, or is capable of being attached and detached on–orbit, and is capable of compensating for thermal expansion of the integrated rack's cooling fluid over the specified temperature range using the specified fill temperature.

E. Verification that the thermal expansion device connected to the integrated rack, non–rack payload or ORU fluid system shall not actuate at less than the specified pressure shall be by test. The verification shall be considered successful when the test shows the device will not expand or contract its fluid volume at less than 100 psia.

4.3.5.1.3 ITCS PRESSURE DROP

4.3.5.1.3.1 ON–ORBIT INTERFACES

A. Verification that the pressure differential measured across the ITCS supply and return interfaces shall be by test with both halves of each mated QD pair included as part of the payload pressure differential. A figure with a curve of flow rate versus pressure drop will be generated for each flow configuration and mode of operation. This curve will show the pressure drop versus flow rate when flow controllers using closed loop control are fully open such that the closed loop control is inactive. The verification shall be considered successful if the test results are within the values specified in the unique payload hardware ICD.

B. Verification that either 1) the pressure drop across the interface is 5.8 ± 0.2 psid (40 ± 1.4 kPa) at any of the operational flow rates of the rack, or 2) the integrated rack can control the operational flow rate at a constant flow rate given that the pressure differential at the interface is 5.8 ± 0.2 psid (40 ± 1.4 kPa), shall be by test with both halves of each mated QD pair included as part of the payload pressure differential. A figure with a curve of flow rate versus pressure drop will show the range of flow rates compatible with a pressure drop of 5.8 ± 0.2 psid (40 ± 1.4 kPa). The verification shall be considered successful when the test confirms that the payload maintains proper flow rates when the interface pressure is controlled at 5.8 ± 0.2 psid (40 ± 1.4 kPa).

4.3.5.1.3.2 MPLM INTERFACES

Verification of the pressure differential measured across the ITCS supply and return interfaces for the flow rate to be used in flight shall be by test with both halves of each mated QD pair included as part of the payload pressure differential and the equivalent of two halves of the QDs subtracted from the value. The verification shall be considered successful if the test results are within the value specified in the unique payload hardware ICD.

4.3.5.1.4 COOLANT FLOW RATE

Verification of compatibility with the design flow rate shall be by analysis or test using the Payload Rack Checkout Unit (PRCU) or equivalent test equipment. The payload developer shall provide the PRCU or equivalent test equipment flow rate measurements for all modes of operations. The verification shall be considered successful if the analysis or test results provide the integrated rack flow rate measurements for all modes of operation at or below the coolant flow rate limits specified in SSP 57001, paragraph 3.5.1.2.

4.3.5.1.5 COOLANT SUPPLY TEMPERATURE

Verification is not required.

4.3.5.1.6 COOLANT RETURN TEMPERATURE

A. Verification that the initial configuration of the integrated rack moderate differential return temperature is above the minimum allowable shall be verified by test and analysis. The test shall utilize a PRCU (or equivalent) to measure the differential temperature for the minimum, maximum and nominal power modes of the integrated rack. Analysis shall be used to account for any on-orbit modifications of equipment, using a thermal model adjusted with the results from the integrated rack return temperature testing, to verify that the changes in equipment satisfy the minimum differential temperature. The verification shall be considered successful when the initial test and subsequent analysis show that the moderate differential return temperature is above the minimum allowable.

B. Verification that the integrated rack using moderate temperature coolant is designed to operate using 100 lbm/hr flow during modes of operation which require less than 1025 watts of power shall be verified by analysis. The verification shall be considered successful when the analysis shows that the integrated rack using moderate temperature coolant is designed to operate using 100 lbm/hr flow during operating modes which require less than 1025 watts of power.

C. Verification that the initial configuration of the integrated rack moderate TCS return temperature does not exceed the maximum specified temperature shall be verified by test and analysis. The test shall utilize a PRCU (or equivalent) to measure the outlet temperature for the maximum and nominal power modes of the integrated rack. Analysis shall be used to account for any on-orbit modifications of equipment, using a thermal model adjusted with the results from the integrated rack return temperature testing, to verify that the changes in equipment do not exceed the allowable return temperature. The verification shall be considered successful when the initial test and subsequent analysis show that the moderate temperature return limit is not exceeded.

D. Verification that the initial configuration of the integrated rack low TCS return temperature does not exceed the maximum specified temperature shall be verified by test and analysis. The test shall utilize a PRCU (or equivalent) to measure the outlet temperature for the maximum and nominal power modes of the integrated rack. Analysis shall be used to account for any on-orbit modifications of equipment, using a thermal model adjusted with the results from the integrated rack return temperature testing, to verify that the changes in equipment do not exceed the allowable return temperature. The verification shall be considered successful when the initial test and subsequent analysis show that the low temperature return limit is not exceeded.

4.3.5.1.7 COOLANT MAXIMUM DESIGN PRESSURE

A. Moderate Temperature Loop

The pressure integrity of integrated rack volumes connected to the TCS moderate temperature loop shall be verified by performing a leak–check of the pressure system. The verification shall be considered successful if the test results show the integrated rack passes the leak–check performed at a minimum of 1.0 x MDP per SSP 52005, paragraph 5.1.3.

B. Low Temperature Loop

The pressure integrity of integrated rack volumes connected to the TCS low temperature loop shall be verified by performing a leak–check of the pressure system. The verification shall be considered successful if the test results show the integrated rack passes the leak–check performed at a minimum of 1.0 x MDP per SSP 52005, paragraph 5.1.3.

C. MPLM Temperature Loop

The pressure integrity of integrated rack volumes connected to the MPLM active thermal control subsystem shall be verified by performing a leak–check of the pressure system. The verification shall be considered successful if the test results show the integrated rack passes the leak–check performed at a minimum of 1.0 x MDP per SSP 52005, paragraph 5.1.3.

4.3.5.1.8 FAIL SAFE DESIGN

Verification that payload equipment and rack internal water loop piping utilizing the Space Station or payload-provided heat rejection system(s) is fail safe in the case of loss of cooling under all modes of operation and will not result in over-temperature, over-pressurization, fire, explosion, release of hazardous or toxic materials or damage that could propagate to other systems shall be by analysis. If loss of cooling results in a hazard, the controls for shutdown must be verified by test. The verification shall be considered successful if the analysis and/or test results show the integrated rack satisfies the fail safe design criteria.

4.3.5.1.9 LEAKAGE

A. Verification that each ITCS fluid loop including all payload equipment and connections as well as the supply and return interfaces and connections at the utility interface panel does not exceed the leakage requirement shall be by test. The leakage test shall be performed at MDP or above. If helium, or some other medium, is used in testing, the results shall be converted to an equivalent water leakage. The verification shall be considered successful if the test results show the integrated rack leakage rate to be equal to or less than $14 \text{ X } 10^{-3}$ scc/hr of liquid per each thermal loop.

   NOTE: A conversion factor of 1 scc/hr of water = 233 scc/hr of helium at a pressure of 121 psia shall be used when converting helium leakage to an equivalent water leakage.

B. Verification that the ITCS fluid loop including all payload equipment and connections as well as the supply and return interfaces and connections at the utility interface panel does not exceed the leakage requirement shall be by test. The leakage test shall be performed at

MDP or above. If helium, or some other medium, is used in testing, the results shall be converted to an equivalent water leakage. The verification shall be considered successful if the test results show the integrated rack leakage rate to be equal to or less than 9×10^{-3} scc/hr of liquid.

NOTE: A conversion factor of 1 scc/hr of water = 386 scc/hr of helium at a pressure of 210 psia shall be used when converting helium leakage to an equivalent water leakage.

4.3.5.1.10 QUICK-DISCONNECT AIR INCLUSION

Verification that air inclusion into the QD during coupling and uncoupling does not exceed 0.3 cc per couple/uncouple cycle for part numbers other than those listed in Table 3.1.1.6.1–1, shall be by test or analysis of QD certification data. If air is not used in testing of the QD, the results shall be converted to an equivalent volume of air. The verification shall be considered successful if the test results show the integrated rack QD air inclusion does not exceed 0.3 cc per couple/uncouple cycle. If the QD used is a dash number of the parts listed in Table 3.1.1.6.1–1, then verification shall be a CoC stating compliance.

4.3.5.1.11 RACK FRONT SURFACE TEMPERATURE

Verification that the average rack front surface temperature and maximum temperature limits will not be exceeded during all modes of operation shall be by analysis or test. The verification shall be considered successful when the analysis or test results show the integrated rack surface average and maximum limit temperatures are less than those specified.

4.3.5.1.12 CABIN AIR HEAT LEAK

Verification that the cabin air heat leak does not exceed the limits specified in SSP 57001, paragraph 3.5.1.8 shall be by analysis. The verification shall be considered successful if the analysis results show the integrated rack does not exceed the cabin air heat leak limits.

4.3.5.1.13 MPLM CABIN AIR COOLING

Verification that the cabin air heat load absorbed by the Integrated racks in the MPLM does not exceed the limits specified in paragraph 3.5.1.13 shall be by analysis. The verification shall be considered successful if the analysis results show the integrated racks do not exceed the cabin air heat load absorption limit.

4.3.5.1.14 SIMULTANEOUS COOLING

A. Verification of simultaneous flow requirements shall be by analysis. The verification shall be considered successful when the analysis results show the integrated rack meets the interfaces for simultaneous flow specified in SSP 57001, paragraph 3.5.1.5.

B. Verification that the moderate temperature loop and low temperature loop coolant flow does not mix together shall be verified by inspecting the engineering drawings. The verification shall be considered successful when the inspection shows the integrated rack thermal systems flow do not mix.

4.3.5.1.15 CONTROL SYSTEM TIME CONSTANT

Verification that the payload control system time constant is of the specified duration shall be by test. The verification shall be considered successful if the test results show the integrated rack time constant for set point changes resulting in flow rate changes greater than five pounds mass flow per hour (5 lbm/hr) shall take the specified time to reach 63.2% (i.e., $1–e^{–1}$) of the commanded change in flow rate.

4.3.5.1.16 PAYLOAD COOLANT QUANTITY

Verification that the maximum allowable payload coolant quantity is not exceed shall be by test or analysis of the payload design drawings. The verification shall be considered successful if the test or analysis results show the integrated rack coolant quantity to be within the limits specified in SSP 57001, paragraph 3.5.1.6.

4.3.6 VACUUM SYSTEM REQUIREMENTS

4.3.6.1 VACUUM EXHAUST SYSTEM REQUIREMENTS

4.3.6.1.1 VES PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.6.1.2 INPUT PRESSURE LIMIT

A. Integrated rack vented gas pressure shall be verified by test and analysis. The test shall utilize a PRCU or equivalent to measure the vented gas pressure at the interface plane. The integrated rack volumes that are connected to ISS VES/WGS shall be pressurized to the expected experiment pressures for the test.

B. The MDP of integrated rack volumes connected to the VES shall be verified by the test and analysis guidelines identified in SSP 52005, paragraph 5.1.3

C. An analysis shall determine whether or not the payload system (including the experiment chamber) connected to the ISS VES/WGS system provides a two fault tolerant design to prevent venting gases at pressures greater than 276 kPa (40 psia) at the rack to station interface. Verification shall be considered successful when the analysis shows the payload system provides a two fault tolerant design to prevent venting gases to the ISS VES/WGS system at pressures greater than 276 kPa (40 psia) at the rack to station interface.

4.3.6.1.3 INPUT TEMPERATURE LIMIT

A. Integrated rack temperature shall be verified by test. The test shall utilize a PRCU or equivalent to measure the temperature at the interface plane. The integrated rack volumes that are connected to VES shall be pressurized to the expected pressures for the test. The experiment shall be subjected to the same heat generating operations that will be experienced on-orbit and vented at the same relative time during the experiment operation as would be experienced on-orbit.

4.3.6.1.4 INPUT DEWPOINT LIMIT

Integrated rack dewpoint shall be verified by test. The test shall utilize a PRCU or equivalent to measure the dewpoint at the interface plane. The integrated rack volumes that are connected to VES shall be pressurized to the expected pressures for the test. The experiment shall be subjected to the same operations that will be experienced on-orbit and vented at the same relative time during the experiment operation as would be experienced on-orbit.

4.3.6.1.5 ACCEPTABLE EXHAUST GASES

A. Verification that exhaust gases vented into the Vacuum Exhaust System/Waste Gas System (VES/WGS) of the USL, APM, and JEM are compatible with the wetted surface materials of the respective laboratory(ies) in which the integrated rack will operate shall be by analysis or test. Gases documented in Appendix D have been analyzed for compatibility with the ISS VES/WGS wetted materials. The integrated rack provider shall submit a complete list of all proposed vent gas constituents, initial volume, concentration, temperature and pressure to the ISS program. The list submitted shall also identify which exhaust gases will be vented together and shall include the products of any reactions determined in 3.6.1.5 B. The ISS module integrator will analyze the list of vent gases not specified in Appendix D and the VES/WGS wetted surface materials to determine whether or not the proposed exhaust gases are compatible with the ISS VES/WGS wetted materials. NASA will perform this compatibility analysis or test for NASA payloads in the JEM.

The ISS Program will evaluate and conduct a test, if necessary for gases that do not have compatibility documentation to determine whether or not the proposed exhaust gases are compatible with the VES/WGS wetted surface materials. The payload developer shall review the integrated racks proposed vent gases and determine whether or not the gases are listed as acceptable in Appendix D or on the report provided by the program in the stage analysis. Verification shall be considered successful when the proposed exhaust gases are shown to be compatible with the ISS VES/WGS wetted surface materials of the respective laboratory(ies) in which the integrated rack will operate as specified in Appendix D or in the analysis report from the ISS program. The verification process performed by the ISS program is documented in SSP 57011, Figure 3.4.11–9.

Note: This analysis/test will consider flammability, pitting and general corrosion, and degradation and swelling of seal materials. An analysis will consist of a literature search that will review technical documentation for documented compatibility of exhaust gases with the wetted materials listed in SSP 41002, paragraph 3.3.7.2. Materials and gases will be considered compatible if the documentation shows one of the following: existing use of the material in a system containing the gas in question, test data showing compatibility, or general materials information stating compatibility. For exhaust gases where no technical data showing compatibility is found, a test will be conducted. The test will review material weight loss, wetted material surface changes, soft material swelling and wetted material trace contaminate inclusion in the test gases after exposure to the materials.

B. **(TBR #12)** Verification that integrated rack gases vented to the ISS VES/WGS are non–reactive with other vent gas mixture constituents shall be by analysis. An analysis shall determine what gases will be vented to the ISS VES/WGS and, assuming the worst case reactions possible, shall determine all reactions that are possible among the vent gas constituents. An analysis shall calculate the worst case temperature change associated with the possible vent gas reactions in accordance with the equation :

$$\boxed{20 \geq \frac{\Sigma_{\text{ALL REACTIONS}} \left[\left[\dfrac{(\Sigma x_p H_p - \Sigma x_{r1} H_r)}{n_{lim}} \right] m_{lim} \right]}{\Sigma x_p m_p c_{pp} + \Sigma x_{r2} m_r c_{pr} + \Sigma x_d m_d c_{pd}}}$$

H_p	=	Enthalpy of formation of the products (J/mol)
H_r	=	Enthalpy of formation of the reactants (J/mol)
X_{r1}	=	Number of moles of the reactants
X_{r2}	=	Number of moles of the unreacted reactants
X_p	=	Number of moles of the products
X_d	=	Number of moles of the diluent
n_{lim}	=	Molecular Weight of the limiting reactant in the reaction (g/mol)
m_{lim}	=	Mass of the limiting reactant in the reaction (g)
m_p	=	Mass of each product gas in the vent mixture (g)
m_r	=	Mass of each unreacted reactant gas in the vent mixture (g)
m_d	=	Mass of each diluent gas in the vent mixture (g)

c_{pp} = Constant Pressure Heat Capacity of each product gas at the vented condition (J/(g*K))

c_{pr} = Constant Pressure Heat Capacity of each unreacted gas at the vented condition (J/(g*K))

c_{pd} = Constant Pressure Heat Capacity of each diluent gas at the vented condition (J/(g*K))

Note: The exact equation used may vary slightly depending on the units of the data available for the given gases. These variations shall be limited to units conversions only. The final units of the equation should be a measure of temperature, measured in Celsius or Kelvin.

For each possible reaction in the vent gas mixture, all gases associated with the reaction shall be included in the calculation in the numerator. All possible reactions in the vent gases mixture shall be calculated and summed together in the numerator. All gases in the vented mixture should be included in the denominator of the analysis. Unreacted reactants may be summed in the denominator as a diluent, when rich or lean mixtures are expected for a given reaction. When lean or rich mixtures are expected for one reaction, an analysis shall show that the excess reactant gases will not react with another gas in the vent mixture (the original reaction considered should be the worst case, i.e. most energy released, reaction).

If trace elements (up to the SMAC value) are present and do not participate in a reaction, they may be excluded from this analysis.

Verification shall be considered successful when the analysis shows the gases vented to the ISS VES/WGS are non–reactive according to the equation specified above (the equation meets the inequality).

Note: Venting of cabin air or the ISS pressurized gases, Nitrogen, Carbon Dioxide, Argon or Helium, or mixtures of these gases are considered acceptable and do not require verification if they are not mixed with other gases.

C. Verification that integrated racks venting to the ISS VES/WGS provide a means of removing gases that would adhere to the VES/WGS tubing walls at a wall temperature of 4°C (40°F) and a pressure of 10 (–3) torr shall be by analysis. An analysis shall determine whether or not the gas mixture contains gases with a molecular weight greater than 75 amu or gases which have a boiling point greater than 100°C (212°F) at atmospheric pressure.

Each proposed vent gas with a molecular weight greater than 75 amu or a boiling point greater than 100°C (212°F) at atmospheric pressure shall be analyzed to determine whether or not the vapor pressure is below a pressure of 10 (–3) torr at 4°C (40°F). This analysis shall be conducted gas–by–gas. If any proposed vent gases are determined to have a vapor pressure below 10 (–3) torr at 4°C (40°F), an analysis shall be conducted to determine whether or not the integrated rack provides a means to remove these gases from the vent gas mixture prior to venting to the ISS VES/WGS.

Or alternatively, each proposed vent gas with a molecular weight greater than 75 amu or a boiling point greater than 100°C (212°F) at atmospheric pressure shall be analyzed to determine whether or not the boiling temperature is above 4°C (40°F) at a pressure of 10 (–3) torr. This analysis shall be conducted gas–by–gas. If any proposed vent gases are determined to have a boiling temperature above 4°C (40°F) at 10 (–3) torr, an analysis shall be conducted to determine whether or not the integrated rack provides a means to remove these gases from the vent gas mixture prior to venting to the ISS VES/WGS.

The Clausius–Clapeyron equation or Antoines equation may be used to verify this requirement. Note that it is not required to use these equations, but they may be helpful.

Verification shall be considered successful when the analysis shows the gases that will be exposed to the ISS VES/WGS will not adhere to the ISS VES/WGS tubing walls at a wall temperature of 4°C (40°F) at 10 (–3) torr. Gases that will be exposed to the ISS VES/WGS will not adhere to the ISS VES/WGS tubing walls when each vent gas is shown to have a vapor pressure above 10 (–3) torr ar 4°C (40°F) or a boiling temperature below 4°C (40°F) at a pressure of 10 (–3) torr and /or, any gases found with a vapor pressure below 10 (–3) torr at 4°C (40°F) or a boiling temperature above 4°C (40°F) at a pressure of 10 (–3) torr are removed from the gas mixture.

Note: Cabin air and the ISS Pressurized gases, nitrogen, argon, helium and carbon dioxide, may be vented to the ISS VES/WGS without verification of this requirement.

D. Verification that integrated racks venting to the ISS VES/WGS remove particulates from vent gases that are larger than 100 micrometers shall be by analysis. An analysis shall determine whether or not the vent gases will contain particulate contamination larger than 100 microns. Should the analysis show that particulate contamination greater than 100 microns will be introduced into, or generated in, the vent gases, an analysis shall determine whether or not a means or removing the particles above 100 microns before venting to the ISS VES/WGS is included in the integrated rack design. Verification shall be considered successful when the analysis shows the vent gases will not contain particulate contamination greater than 100 microns.

Note: ISS Cabin Atmosphere and the ISS Pressurized gases, nitrogen, argon, helium and carbon dioxide, may be vented to the ISS VES/WGS in the condition delivered to the integrated rack if it’s shown that particulate contamination is not generated within the integrated rack.

4.3.6.1.5.1 ACCEPTABLE GASES – INITIAL LIST

A. NVR

B. NVR

C. NVR

4.3.6.1.5.2 EXTERNAL CONTAMINATION CONTROL

Verification shall be by analysis. The integrated rack provider shall submit the list of vented gas constituents, volume, initial temperature and pressure to the ISS program. The verification shall be considered successful when the Environments Team verifies that the vented gases do not exceed the external contamination limits in the specified section of SSP 30426.

4.3.6.1.6 PAYLOAD VACUUM SYSTEM ACCESS VALVE

Verification that integrated racks using the VES/WGS system provide a vacuum system access valve in the integrated rack system to isolate the experiment chamber from the ISS VES/WGS system shall be by inspection and analysis.

An analysis of the integrated rack list of vent gases shall determine whether or not the integrated rack will vent gases other than the constituents of cabin air, noble gases or ISS pressurized gases. If the analysis shows only the constituents of cabin air, noble gases or ISS pressurized gases will be vented from the integrated rack, the integrated rack vacuum system access valve is not required.

For integrated racks found to be venting gases other than the constituents of cabin air, noble gases or ISS pressurized gases, an inspection of the integrated rack as–build drawings or flight hardware shall be performed. This inspection shall determine whether or not the integrated rack system contains a vacuum system access valve that isolates the experiment chamber from the ISS VES/WGS system.

Verification shall be considered successful when the inspection and analysis shows that a vacuum system access valve, isolating the experiment chamber from the ISS VES/WGS, is provided if the integrated rack will vent gases other than the constituents of cabin air, noble gases or ISS pressurized gases. The integrated rack vacuum system access valve is not required if the integrated rack is venting only the constituents of cabin air, noble gases or ISS pressurized gases.

4.3.6.2 VACUUM RESOURCE SYSTEM REQUIREMENTS

4.3.6.2.1 VRS PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.6.2.2 INPUT PRESSURE LIMIT

A. Integrated rack vented gas pressure shall be verified by test. The test shall utilize a PRCU or equivalent to measure the vented gas pressure at the interface plane. The integrated rack volumes that are connected to ISS VRS/VVS shall be pressurized to the expected experiment pressures for the test.

B. The MDP of integrated rack volumes connected to the VRS/VVS shall be verified by the test and analysis guidelines identified in SSP 52005, paragraph 5.1.3.

C. An analysis shall determine whether or not the payload system (including the experiment chamber) connected to the ISS VRS/VVS system provides a two fault tolerant design to prevent venting gases at pressures greater than 276 kPa (40 psia) at the rack to station interface. Verification shall be considered successful when the analysis shows the payload system provides a two fault tolerant design to prevent venting gases to the ISS VRS/VVS system at pressures greater than 276 kPa (40 psia) at the rack to station interface.

4.3.6.2.3 VRS THROUGH-PUT LIMIT

The throughput to the VRS shall be verified by the test. The test shall utilize a PRCU or equivalent to measure the vented gas throughput at the interface plane.

4.3.6.2.4 ACCEPTABLE EXHAUST GASES

NVR

4.3.7 PRESSURIZED GASES INTERFACE REQUIREMENTS

4.3.7.1 NITROGEN INTERFACE REQUIREMENTS

4.3.7.1.1 NITROGEN INTERFACE CONTROL

A. Verification of nitrogen on and off flow control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack valve can turn on and off the flow of nitrogen.

B. Verification of nitrogen flow rate control shall be by test. The verification shall be considered successful when the test results confirm the integrated rack can control the flow to not exceed the maximum allowable nitrogen flow rate when connected to nitrogen supplied at the maximum and minimum of the specified pressure range.

4.3.7.1.2 NITROGEN INTERFACE MDP

The MDP of integrated rack volumes connected to the Nitrogen system shall be verified by test and analysis guidelines identified in SSP 52005, paragraphs 3.3.1, 3.3.1.1, 5.1.3, 5.3.2.2, 6.2.3, 6.2.4 and 7.4. The verification shall be considered successful if the test and analysis results show that the integrated rack can meet or exceed the requirements in SSP 52005.

4.3.7.1.3 NITROGEN INTERFACE TEMPERATURE

NVR

4.3.7.1.4 NITROGEN LEAKAGE

Verification of integrated rack nitrogen leakage at MDP shall be by test at MDP or by test at MEOP and analysis to MDP. The verification shall be considered successful when the test or test and analysis results show that the leakage sources from the standoff UIP panel connection to nitrogen on/off flow control in the integrated rack does not exceed the allowable leakage rate at MDP.

4.3.7.1.5 NITROGEN PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.7.2 ARGON INTERFACE REQUIREMENTS

4.3.7.2.1 ARGON INTERFACE CONTROL

A. Verification of argon on and off flow control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack valve can turn on and off the flow of argon.

B. Verification of argon flow rate control shall be by test. The verification shall be considered successful when the test results confirm the integrated rack can control the flow to not exceed the maximum allowable argon flow rate when connected to argon supplied at the maximum and minimum of the specified pressure range.

4.3.7.2.2 ARGON INTERFACE MDP

The MDP of integrated rack volumes connected to the Argon system shall be verified by test and analysis per the guidelines identified in SSP 52005, paragraphs 3.3.1, 3.3.1.1, 5.1.3, 5.3.2.2, 6.2.3, 6.2.4 and 7.4. The verification shall be considered successful if the test and analysis results show that the integrated rack can meet or exceed the requirements in SSP 52005.

4.3.7.2.3 ARGON INTERFACE TEMPERATURE

NVR

4.3.7.2.4 ARGON LEAKAGE

Verification of integrated rack argon leakage at MDP shall be by test at MDP or by test at MEOP and analysis to MDP. Verification shall be considered successful when the test or test and analysis results show that the leakage sources from the standoff UIP panel connection to the argon on/off flow control in the integrated rack does not exceed the allowable leakage rate at MDP.

4.3.7.2.5 ARGON PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.7.3 CARBON DIOXIDE INTERFACE REQUIREMENTS

4.3.7.3.1 CARBON DIOXIDE INTERFACE CONTROL

A. Verification of carbon dioxide on and off flow control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack can turn on and off the flow of carbon dioxide.

B. Verification of carbon dioxide flow rate control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack can control the flow to not exceed the maximum allowable carbon dioxide flow rate when connected to carbon dioxide supplied at the maximum and minimum of the specified pressure range.

4.3.7.3.2 CARBON DIOXIDE INTERFACE MDP

The MDP of integrated rack volumes connected to the Carbon Dioxide system shall be verified by test and analysis per the guidelines identified in SSP 52005, paragraphs 3.3.1, 3.3.1.1, 5.1.3, 5.3.2.2, 6.2.3, 6.2.4 and 7.4. The verification shall be considered successful if the test and analysis results show that the integrated rack can meet or exceed the requirements in SSP 52005.

4.3.7.3.3 CARBON DIOXIDE INTERFACE TEMPERATURE

NVR

4.3.7.3.4 CARBON DIOXIDE LEAKAGE

Verification of integrated rack carbon dioxide leakage at MDP shall be by test at MDP or by test at MEOP and analysis to MDP. The verification shall be considered successful when the test or test and analysis results show that the leakage sources from the standoff UIP panel connection to the carbon dioxide on/off flow control in the integrated rack does not exceed the allowable leakage rate at MDP.

4.3.7.3.5 CARBON DIOXIDE PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in Section 4.3.1.1.6.1.

4.3.7.4 HELIUM INTERFACE REQUIREMENTS

4.3.7.4.1 HELIUM INTERFACE CONTROL

A. Verification of helium on and off flow control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack valve can turn on and off the flow of helium.

B. Verification of helium flow rate control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack can control the flow to not exceed the maximum allowable helium flow rate when connected to helium supplied at the maximum and minimum of the specified pressure range.

4.3.7.4.2 HELIUM INTERFACE MDP

The MDP of integrated rack volumes connected to the Helium system shall be verified by test and analysis per the guidelines identified in SSP 52005, paragraphs 3.3.1, 3.3.1.1, 5.1.3 5.3.2.2, 6.2.3, 6.2.4 and 7.4. The verification shall be considered successful if the test and analysis results show the integrated rack can meet or exceed the requirements in SSP 52005.

4.3.7.4.3 HELIUM INTERFACE TEMPERATURE

NVR

4.3.7.4.4 HELIUM LEAKAGE

Verification of integrated rack helium leakage at MDP shall be by test at MDP or by test at MEOP and analysis to MDP. Verification shall be considered successful when the test or test and analysis results show that the leakage sources from the standoff UIP panel connection to the helium on/off flow control in the integrated rack does not exceed the allowable leakage rate specified at MDP.

4.3.7.4.5 HELIUM PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.7.5 PRESSURIZED GAS SYSTEMS

Verification of the expanded volume and flow rate for pressurized gas systems shall be by analysis. The verification shall be considered successful when the analysis of the drawings shows that the expanded volume of the gas in the pressurized system is below the limiting volume specified. If the volume exceeds the limiting specified volume, then an analysis must be performed verifying that the flow rate after a single failure does not exceed the maximum allowable amount after release of the limiting expanded volume.

4.3.7.6 MANUAL VALVES

Verification that manual valves used to control the flow of pressurized gases are accessible without rack rotation shall be by inspection. Verification shall be considered successful when inspection of the flight article shows that the manual valve is accessible for manual operation without having to rotate the rack.

4.3.8 PAYLOAD SUPPORT SERVICES INTERFACES VERIFICATION REQUIREMENTS

4.3.8.1 POTABLE WATER

NVR

4.3.8.1.1 POTABLE WATER INTERFACE CONNECTION

NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.8.1.2 POTABLE WATER INTERFACE PRESSURE

Verification that the payload-provided container, and all hoses, tubing, and connectors used with the ISS potable water interface, do not leak when exposed to the ISS potable water interface pressure specified shall be by test. The verification shall be considered successful when the test shows that the container, and all hoses, tubing, and connectors used with the ISS potable water interface, do not visibly leak liquid water when pressurized to the maximum water pressure specified.

4.3.8.1.3 POTABLE WATER USE

A. Verification that the integrated rack use of water from the ISS water system that is not returned to the cabin air as humidity does not exceed the specified amount shall be by analysis. The verification shall be successful when the analysis shows that the total use of water that is not returned to the cabin air as humidity does not exceed the specified amount.

B. Verification that the integrated rack total water use from the ISS water system shall be by analysis. The verification shall be successful when the analysis shows that the total use of water does not exceed the specified amount.

4.3.9 ENVIRONMENT INTERFACE VERIFICATION REQUIREMENTS

4.3.9.1 ATMOSPHERE REQUIREMENTS

4.3.9.1.1 PRESSURE

Verification of this requirement shall be according to NSTS 13830, the verification shall be submitted to the PSRP per NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.9.1.2 TEMPERATURE

Verification of this requirement shall be according to NSTS 13830, the verification shall be submitted to the PSRP per NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.9.1.3 HUMIDITY

Verification that the integrated rack is designed to not cause condensation when exposed to the specified dewpoint and relative humidity except when condensation is an intended operation of the integrated rack shall be by analysis. The verification shall be considered successful when analysis shows that no internal or external surfaces in contact with the cabin air will allow condensation when humidity and dewpoint are within the ISS atmosphere envelope defined by Figure 3.9.1.3–1. Surfaces shall be considered to be in contact with the cabin air unless a volume is hermetically sealed or environmentally conditioned to control humidity.

4.3.9.2 INTEGRATED RACK USE OF CABIN ATMOSPHERE

4.3.9.2.1 ACTIVE AIR EXCHANGE

A. Verification that active air exchange with the cabin atmosphere by an integrated rack is limited to air exchange for specimen metabolic purposes and for mass conservation purposes shall be by inspection. The verification shall be considered successful when inspection of the flight drawings shows that the rack and sub-rack payloads limit air exchange with cabin for the specified purposes.

B. Verification that aisle mounted payload and payload equipment heat loads imposed on cabin air is within the specified limits for each module shall be by analysis. The verification shall be considered successful when the analysis shows that aisle mounted payload and payload equipment heat loads will not exceed the specified allowable limits for cabin air heat rejection specified for each module.

4.3.9.2.2 OXYGEN CONSUMPTION

Verification that the integrated rack consumption of atmospheric oxygen does not exceed the specified amount shall be by analysis. The verification shall be considered successful when analysis shows that the integrated rack consumption of atmospheric oxygen shall not exceed the daily allowable amount specified.

4.3.9.2.3 CHEMICAL RELEASES

Verification of this requirement shall be according to NSTS 13830, the verification shall be submitted to the PSRP per NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.9.3 IONIZING RADIATION REQUIREMENTS

4.3.9.3.1 INTEGRATED RACK CONTAINED OR GENERATED IONIZING RADIATION

Verification that Payloads containing or using radioactive materials or generating ionizing radiation meet the requirements of 1700.7 ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.9.3.2 IONIZING RADIATION DOSE

NVR

4.3.9.3.3 SINGLE EVENT EFFECT (SEE) IONIZING RADIATION DOSE

Verification that equipment and subsystems are designed to not produce an unsafe condition or one that could cause damage to equipment external to the payload as a result of exposure to SEE ionizing radiation shall be by analysis. An analysis of equipment and subsystems shall be performed using the operational lifetime and parts characterization data to assure that the design meets the requirement when exposed to SEE ionizing radiation. The verification shall be considered successful when the analysis shows that the equipment and subsystems will not produce an unsafe condition or one that could cause damage to equipment external to the payload when exposed to the specified environment.

4.3.9.3.4 LAB WINDOW RACK LOCATION RADIATION REQUIREMENTS

NVR

4.3.9.3.4.1 WINDOW RACK INFRARED RADIATION REQUIREMENTS

Verification that shielding is provided that reduces the infrared transmittance to less than 10.0 percent for wavelengths between 850 and 1000 nanometers shall be by test. A test shall determine whether or not the shielding reduces infrared transmittance to less than 10.0 percent of the environment specified in Table 3.9.3.4–1 for wavelengths between 850 and 1000 nanometers. Verification shall be considered successful when the test shows shielding is provided that reduces the infrared transmittance to less than 10.0 percent for wavelengths between 850 and 1000 nanometers.

4.3.9.3.4.2 WINDOW RACK ULTRAVIOLET RADIATION REQUIREMENTS

Verification that shielding is provided that reduces the Ultraviolet transmittance to less than 0.01 percent fro wavelengths between 220 and 280 nanometers and less than 0.1 percent for wavelengths between 280 and 320 nanometers shall be by test. A test shall determine whether or not the shielding reduces the Ultraviolet transmittance to less than 0.01 percent for wavelengths between 220 and 280 nanometers and less than 0.1 percent for wavelengths between 280 and 320 nanometers, with an external ultraviolet environment as specified in Table 3.9.3.4–1. Verification shall be considered successful when the test shows shielding is provided that reduces the Ultraviolet transmittance to less than 0.01 percent for wavelengths between 220 and 280 nanometers and less than 0.1 percent for wavelengths between 280 and 320 nanometers.

4.3.9.4 ADDITIONAL ENVIRONMENTAL CONDITIONS

NVR

4.3.10 FIRE PROTECTION INTERFACE REQUIREMENTS

4.3.10.1 FIRE PREVENTION

Verification that integrated racks and aisle mounted equipment meet the fire prevention requirements specified in NSTS 1700.7 ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.10.2 PAYLOAD MONITORING AND DETECTION REQUIREMENTS

Verification that integrated racks and sub–rack volumes/payloads meet the safety monitoring and detection requirements specified in NSTS 1700.7 ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and/or safety data presented to the PSRP during the phased safety reviews are approved.

4.3.10.2.1 SMOKE DETECTION

4.3.10.2.1.1 SMOKE DETECTOR

A. Verification that integrated racks requiring smoke detection use a smoke detector that meets the requirements specified in SSP 30262:013 shall be by inspection. Verification shall be considered successful when the inspection shows the end item spec and interface control document of the smoke detector used meets the requirements specified in SSP 30262:013. Integrated racks using the ISS provided smoke detector (Allied Signal P/N 2351520–2–1 or P/N 2119818–3–1 for area type, or Allied Signal P/N 2351510–2–1 or P/N 2119814–3–1 for duct type) shall be considered in compliance with this requirement.

B. Verification that integrated racks requiring a smoke detector provide a smoke detector interface at the J43 connection shall be by inspection and demonstration. The inspection shall consist of reviewing schematics/drawings to verify they show wiring to the J43 connector. The verification shall be considered successful when the inspection shows wiring from smoke detector to the J43 connector. The demonstration shall be conducted to show the connector mates with the ISS equivalent connector. The verification shall be considered successful when the demonstration shows the connector mates with the ISS equivalent connector.

4.3.10.2.1.2 FORCED AIR CIRCULATION INDICATION

Verification that integrated racks provide a signal or data indicating the presence of airflow to the smoke detector when the smoke detector is in use shall be by test. Verification shall be considered successful when the test shows signal strength meets the interface characteristics in paragraph 3.3.10.

4.3.10.2.1.3 FIRE DETECTION INDICATOR

A. Verification that integrated racks using a smoke detector provide a red Fire Detection Indicator LED in an easily visible location on the front of the rack shall be by test and inspection. The test shall show the LED meets or exceeds the operational characteristics of the ISS provided LED when provided the interface characteristics defined in paragraph 3.3.10. Test verification shall be considered successful when the test shows the indicator LED meets or exceeds the operational characteristics of the ISS provided LED when provided the interface characteristics defined paragraph 3.3.10. Integrated racks using the ISS provided Fire Detection Indicator LED shall be considered in compliance with this requirement. The inspection shall show the LED is positioned in an obvious, easily viewed location on the aisle side of the rack. Inspection verification shall be considered successful when the inspection shows the LED is positioned in an obvious, easily viewed location on the aisle side of the rack.

B. Verification that integrated racks requiring a fire detection indicator provide a fire detection indicator interface at the J43 connection shall be by inspection. The inspection shall consist of reviewing schematics/drawings to verify they show wiring to the J43 connector. The verification shall be considered successful when the inspection shows wiring from the fire detection indicator to the J43 connector.

4.3.10.2.2 PARAMETER MONITORING

4.3.10.2.2.1 PARAMETER MONITORING USE

Verification that integrated rack or sub-rack volumes which contain a potential fire source and do not exchange air with the rack smoke detector provide sensors that will monitor that volume to detect a fire event shall be by analysis and inspection. An analysis of the payload volume design shall be conducted to determine whether or not the volume contains a potential fire source. If there is a potential fire source present, an inspection of drawings or hardware shall be conducted to determine whether or not the volume contains the sensors to detect a fire event as approved by the PSRP during the phased safety reviews. Verification shall be considered successful when the inspection and analysis shows there are sensors, as approved by the PSRP during the phased safety reviews, to detect a fire event in a volume that contains a potential fire source and does not exchange air with the rack smoke detector.

4.3.10.2.2.2 PARAMETER MONITORING RESPONSE

4.3.10.2.2.2.1 PARAMETER MONITORING IN SUB–RACK

A. Verification that the integrated rack provides manual and automatic capabilities to terminate forced air circulation (if present) and power to each sub-rack volume/payload that is monitored with parameter monitoring shall be by test. A test shall be conducted to determine whether or not forced air circulation (if present) and electrical power can be manually and automatically terminated in the sub-rack volume/payload when a potential fire event condition is indicated by the parameter monitoring sensors. Verification shall be considered successful when the test shows forced air circulation (if present) and electrical power can be terminated manually and automatically when a potential fire event condition is indicated by the parameter monitoring sensors.

B. Verification that the integrated rack responds to a potential fire event within a separate, sub-rack volume/payload that is monitored with parameter monitoring by sending data to indicate the location of the potential fire event, data indicating which parameter annunciated the potential fire event and the data for evaluating the potential fire event to the payload MDM in the format specified in paragraph 3.3.5.1.4.A shall be by test and analysis. For the initial configuration of the integrated rack, a test with the PRCU or equivalent shall determine whether or not the rack health and status data is formatted to indicate the location of a potential fire event, data indicating which parameter annunciated the potential fire event and the data for evaluating the potential fire event when one is indicated by parameter monitoring sensors. For sub-rack volumes/payloads that are changed out, a test of the interface to the integrated rack's controller or equivalent and an analysis to determine the interface to the Payload MDM is correct shall be conducted. Verification shall be considered successful when the test and analysis shows data is sent in the format specified in paragraph 3.3.5.1.4.A to indicate the location of a potential fire event, data indicating which parameter annunciated the potential fire event and the data for evaluating the potential fire event when one is indicated by the parameter monitoring sensors.

C. Verification that the integrated rack responds to a potential fire event within a separate sub–rack volume/payload that is monitored with parameter monitoring by sending a Class 2 – Warning word to indicate the occurrence of the potential fire event to the payload MDM in the format specified in paragraph 3.3.5.1.4.B shall be by test and analysis. For the initial configuration of the integrated rack, a test with the PRCU or equivalent shall determine whether or not the rack health and status data is formatted to indicate the occurrence and location of a potential fire event when one is indicated by parameter monitoring sensors. For sub–rack volumes/payloads that are changed out, a test of the interface to the integrated rack's controller or equivalent and an analysis to determine the interface to the Payload MDM is correct shall be conducted. Verification shall be considered successful when the test and analysis shows that the Class 2 – Warning word is sent in the format specified in paragraph 3.3.5.1.4.B to indicate the occurrence of a potential fire event when one is indicated by the parameter monitoring sensors.

4.3.10.2.2.2.2 PARAMETER MONITORING IN INTEGRATED RACK

A. Verification that integrated racks only using parameter monitoring provide manual and automatic capability to terminate forced air circulation (if present) and power to the integrated rack shall be by test. A test with the PRCU or equivalent shall be conducted to determine whether or not forced air circulation (if present) and electrical power can be manually and automatically terminated in the integrated rack when a potential fire event is indicated by the parameter monitoring sensors. Verification shall be considered successful when the test shows forced air circulation (if present) and electrical power can be terminated manually and automatically when a potential fire event is indicated by the parameter monitoring sensors.

B. Verification that integrated racks only using parameter monitoring responds to a potential fire event by sending data to indicate the occurrence and location of the potential fire event to the payload MDM in the format specified in paragraph 3.3.5.1.4.A shall be by test. A test with the PRCU or equivalent shall determine whether or not the rack health and status data is formatted to indicate the occurrence and location of a potential fire event when one is indicated by parameter monitoring sensors. Verification shall be considered successful when the test shows data is sent in the format specified in paragraph 3.3.5.1.4 to indicate the occurrence and location of a potential fire event when one is indicated by the parameter monitoring sensors.

C. Verification that the integrated rack responds to a potential fire event that is monitored with parameter monitoring by sending a Class 2 – Warning word to indicate the occurrence of the potential fire event to the payload MDM in the format specified in paragraph 3.3.5.1.4.B shall be by test and analysis. For the initial configuration of the integrated rack, a test with the PRCU or equivalent shall determine whether or not the rack health and status data is formatted to indicate the occurrence and location of a potential fire event when one is indicated by parameter monitoring sensors. Verification shall be considered successful when the test and analysis shows that the Class 2 – Warning word is sent in the format specified in paragraph 3.3.5.1.4.B to indicate the occurrence of a potential fire event when one is indicated by the parameter monitoring sensors.

4.3.10.3 FIRE SUPPRESSION

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4.3.10.3.1 PORTABLE FIRE EXTINGUISHER

A. Verification that integrated racks and subracks provide a PFE access port for each rack volume containing a potential fire source shall be by inspection and analysis. An analysis of the payload volume design shall be conducted to determine whether or not the payload volume contains a potential fire source. If there is a potential fire source present, an inspection shall be conducted to determine whether or not an access port with a diameter between 12.7 mm (0.5 inch) and 25.4 mm (1.0 inch) is provided, if the panel thickness is less than or equal to 3.175 mm (0.125 inch). Verification shall be considered successful when the inspection of the drawings or hardware show an access port with a diameter between 12.7 mm (0.5 inch) and 25.4 mm (1.0 inch) is provided for each volume containing a potential fire source if the panel thickness is less than 3.175 mm (0.125 inch).

B. Verification that integrated racks and subracks provide a PFE access port for each rack volume containing a potential fire source shall be by inspection and analysis. An analysis of the payload volume design shall be conducted to determine whether or not the payload volume contains a potential fire source. If there is a potential fire source present, an inspection shall be conducted to determine whether or not an access port with a diameter of 25.4 mm (1.0 inch) in diameter is provided, if the panel thickness is greater than 3.175 mm (0.125 inch). Verification shall be considered successful when the inspection of the drawings or hardware show an access port with a diameter of 25.4 mm (1.0 inch) is provided for each volume containing a potential fire source if the panel thickness is equal to or greater than 3.175 mm (0.125 inch).

4.3.10.3.2 FIRE SUPPRESSION ACCESS PORT ACCESSIBILITY

Verification that the design of the integrated rack permits the PFE nozzle to interface with the access port shall be by demonstration. Verification shall be considered successful when the demonstration shows the design of the integrated rack, including protrusions, allows the PFE nozzle to interface with the access port over the face of the integrated rack, without relying on areas adjacent to the integrated rack.

4.3.10.3.3 FIRE SUPPRESSANT DISTRIBUTION

Verification that the internal layout of the integrated rack will allow ISS PFE fire suppressant to be distributed to the entire volume that PFE Access Port serves, lowering the Oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute shall be by analysis or test. Referring to rack qualification tests, which show the ISS PFE will reduce the rack volume Oxygen concentration to or below 10.5% by volume within one minute, an analysis shall be performed on the integrated rack to determine whether or not the internal layout of the integrated rack prevents suppressant from flowing to any volume internal to the volume that PFE Access Port serves. When verified by test, the test shall be performed to determine whether or not the ISS PFE fire suppressant, as specified in Figure 3.1.1.4–1, is distributed to the entire volume that PFE Access Port serves, lowering the Oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute. Verification shall be considered successful when the analysis or test shows the internal layout of the integrated rack will allow ISS PFE fire suppressant to be distributed to the entire volume a PFE Access Port serves, lowering the Oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute.

4.3.10.4 LABELING

A. Verification that the PFE access port is labeled with a SDD32100397–003 or a SDD32100397–004 “Fire Hole Decal” shall be by inspection. Verification shall be considered successful when the inspection shows a SDD32100397–003 or a SDD32100397–004 ”Fire Hole Decal” has been placed over the PFE access port.

Note: IPLAT will perform label verification.

B. Verification that integrated racks requiring a Fire Detection Indicator LED label the Fire Detection Indicator LED “SMOKE INDICATION” shall be by inspection. Verification shall be considered successful when the inspection shows the label “SMOKE INDICATION” has been placed above the Fire Detection Indicator LED using lettering per MSFC–STD–275 with 3.96 mm (0.156 inch) letters, style Futura Demibold, and color 37038 (Lusterless Black) per FED–STD–595. Integrated racks using the ISS provided LED on the rack maintenance switch assembly with the engraved “SMOKE INDICATION” label shall be considered in compliance with this requirement.

4.3.11 MATERIALS AND PARTS INTERFACE VERIFICATION REQUIREMENTS

4.3.11.1 MATERIALS AND PARTS USE AND SELECTION

Verification that parts and materials, and COTS parts meet the requirements of NSTS 1700.7 ISS Addendum shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.11.2 FLUIDS (TBR #14)

4.3.11.2.1 FLUID CHEMICAL COMPOSITION

A. Verification of LTL and MTL fluid physical and chemical characteristics shall be by test. A test shall be conducted according to the verification test requirements specified in SSP 30573B, Section 4.0, to determine whether or not the fluid contained in the integrated rack satisfies the fluid physical and chemical characteristics specified in SSP 30573B, Table 4.1–2.8. The verification shall be considered successful if the test results show the integrated rack fluid physical and chemical characteristics meets the fluid chemistry requirements in SSP 30573B, Table 4.1–2.8.

B. Verification of nitrogen fluid physical and chemical characteristics shall be by inspection and test. An inspection shall verify that the certification of the nitrogen supplied to the nitrogen fluid system satisfies the fluid physical and chemical characteristics specified in SSP 30573B, Table 4.1–2.13. A test shall be performed to ensure the nitrogen fluid system has been flushed with no fewer than four volume change–outs of nitrogen and pressurized to less than the 70 psia. The verification shall be considered successful if the inspection results show that the nitrogen provided to the rack meets the fluid chemistry requirements in SSP 30573B, Table 4.1–2.13, that no fewer than four volume change–outs of the nitrogen fluid system was performed, and that the final pressure of the rack is less than 70 psia (480 kPa).

C. Verification of argon fluid physical and chemical characteristics shall be by inspection and test. An inspection shall verify that the certification of the argon supplied to the argon fluid system satisfies the fluid physical and chemical characteristics specified in SSP 30573B, Table 4.1–2.5. A test shall be performed to ensure the argon fluid system has been flushed with no fewer than four volume change–outs of argon and pressurized to less than the 70 psia. The verification shall be considered successful if the inspection results show that the argon provided to the rack meets the fluid chemistry requirements in SSP 30573B, Table 4.1–2.5, that no fewer than four volume change–outs of the argon fluid system was performed, and that the final pressure of the rack is less than 70 psia (480 kPa).

D. Verification of carbon dioxide fluid physical and chemical characteristics shall be by inspection and test. An inspection shall verify that the certification of the carbon dioxide supplied to the carbon dioxide fluid system satisfies the fluid physical and chemical characteristics specified in SSP 30573B, Table 4.1–2.7. A test shall be performed to ensure the carbon dioxide fluid system has been flushed with no fewer than four volume change–outs of carbon dioxide and pressurized to less than the 70 psia. The verification shall be considered successful if the inspection results show that the carbon dioxide provided to the rack meets the fluid chemistry requirements in SSP 30573B, Table 4.1–2.7, that no fewer than four volume change–outs of the carbon dioxide fluid system was performed, and that the final pressure of the rack is less than 70 psia (480 kPa).

E. Verification of helium fluid physical and chemical characteristics shall be by inspection and test. An inspection shall verify that the certification of the helium supplied to the helium fluid system satisfies the fluid physical and chemical characteristics specified in SSP 30573B, Table 4.1–2.9. A test shall be performed to ensure the helium fluid system has been flushed with no fewer than four volume change–outs of helium and pressurized to less than the 70 psia. The verification shall be considered successful if the inspection results show that the helium provided to the rack meets the fluid chemistry requirements in SSP 30573B, Table 4.1–2.9, that no fewer than four volume change–outs of the helium fluid system was performed, and that the final pressure of the rack is less than 70 psia (480 kPa).

4.3.11.2.2 FLUID SYSTEM CLEANLINESS

A. Verification that the integrated rack LTL and MTL fluid systems meet the SSP 30573B, Table 4.1–1.9.2, cleanliness requirements shall be by inspection. The inspection will consist of a review of the LTL and MTL fluid systems as–built drawings and/or manufacturing documentation to insure that appropriate precision cleaning and hardware control requirements are in place. The verification shall be considered successful if the inspection shows that the appropriate precision cleaning and hardware control requirements are in place to insure that SSP 30573B, Table 4.1–1.9.2, cleanliness levels are established and maintained. The following procedures shall be performed prior to connection with GSE or flight hardware thermal control fluid systems at KSC:

(a) Flush ITCS segments with high purity deionized water (SSP 30573B, Table 4.1–2.17 or Table 4.1–2.8 Prior to Chemical Treatment) and purge with nitrogen (SSP 30573B, Table 4.1–2.13 Grade B) to ensure removal of all organic residuals of precision cleaning or precision cleaning verification. Maximum TOC in the flush water is 5 ppm.

(b) Gases used in contact with ITCS fluid will be controlled to a maximum of 5 ppm gaseous hydrocarbons.

(c) Circulate, drain, and refill, or flush ITCS systems with ITCS fluid (SSP 30573B, Table 4.1–2.8) until the TOC has stabilized and is less than 5 ppm. Stabilized TOC is evidenced by two consecutive readings within 10 percent, taken at a time interval of not less than 3 fluid volume turnovers.

0–5 ppm Acceptable	
6–20 ppm	Continue flush process until 5 ppm is obtained
>20 ppm	Return to deionized water or nitrogen flushing and reverify TOC levels before continuing to flush. Microbial count, pH and silver concentration will be measured on fluid that has stabilized. Data are to be recorded in an historical log of the Acceptance Data Package (ADP section II) or other appropriate technical data archival system, and provided to the Boeing Houston Thermal Systems lead for engineering baseline data.

(d) Once a flight ITCS segment is baselined as acceptable, hardware to be attached to that segment will be separately pretreated and verified as compliant with TOC requirements prior to connection with the baselined segment.

(e) Flight elements containing ITCS fluid for over 30 days will be sampled every two weeks for the first month, and then monthly thereafter, and analyzed for pH, TOC silver concentration, and microbial count. A final sampling will be taken prior to close–out for flight elements. Data are to be recorded in historical log of acceptance data package (ADP section II) or other appropriate technical data archival system, and provided to the Boeing Houston Thermal Systems lead for engineering baseline data.

Note: All or part of the procedures a) through e) above may be performed at KSC if the Payload Developer submits an Operations and Maintenance Requirements and Specification Document (OMRSD) via the Payload Data Library (PDL) KSC Technical Requirements Data Set (TRDS).

B. Verification that the integrated rack nitrogen system meets the SSP 30573B, Table 4.1–1.6, cleanliness requirements shall be by inspection. The inspection will consist of a review of the nitrogen system as–built drawings and/or manufacturing documentation to insure that appropriate precision cleaning and hardware control requirements are in place and that the as–built hardware meets or exceeds those requirements. The verification shall be considered successful if the inspection shows that the appropriate precision cleaning and hardware control requirements are in place to insure that SSP 30573B, Table 4.1–1.6, cleanliness levels are established and maintained.

C. Verification that the integrated rack argon system meets the SSP 30573B, Table 4.1–1.6, cleanliness requirements shall be by inspection. The inspection will consist of a review of the argon system as–built drawings and/or manufacturing documentation to insure that appropriate precision cleaning and hardware control requirements are in place and that the as–built hardware meets or exceeds those requirements. The verification shall be considered successful if the inspection shows that the appropriate precision cleaning and hardware control requirements are in place to insure that SSP 30573B, Table 4.1–1.6, cleanliness levels are established and maintained.

D. Verification that the integrated rack carbon dioxide system meets the SSP 30573B, Table 4.1–1.6, cleanliness requirements shall be by inspection. The inspection will consist of a review of the carbon dioxide as–built drawings and/or manufacturing documentation to insure that appropriate precision cleaning and hardware control requirements are in place and that the as–built hardware meets or exceeds those requirements. The verification shall be considered successful if the inspection shows that the appropriate precision cleaning and hardware control requirements are in place to insure that SSP 30573B, Table 4.1–1.6, cleanliness levels are established and maintained.

E. Verification that the integrated rack helium system meets the SSP 30573B, Table 4.1–1.6, cleanliness requirements shall be by inspection. The inspection will consist of a review of the helium system as–built drawings and/or manufacturing documentation to insure that appropriate precision cleaning and hardware control requirements are in place and that the as–built hardware meets or exceeds those requirements. The verification shall be considered successful if the inspection shows that the appropriate precision cleaning and hardware control requirements are in place in insure that SSP 30573B, Table 4.1–1.6, cleanliness levels are established and maintained.

4.3.11.2.3 THERMAL COOLING SYSTEM WETTED MATERIALS

A. Verification of fluid system dissimilar metals compatibility shall be by analysis. The analysis shall compare the as–built drawings and parts list with the materials listed in MSFC–SPEC–250, Table III. Verification success shall be when the analysis of the as–built drawings and parts list show the internal materials used in the integrated rack aqueous fluid systems are compatible according to the table specified. Analysis shall be performed on materials not listed in MSFC–SPEC–250, Table III. Verification success shall be when the analysis of the materials show the internal materials used in the integrated rack aqueous fluid systems do not create a dissimilar metal couple greater than 0.25 Volts with the ISS aqueous fluid system.

B. Verification the the integrated racks connected to the LTL or MTL are composed of wetted materials that do not include aluminum alloys nor alloys with greater than 5% copper shall be by analysis. An analysis of the as built drawings and parts lists shall determine whether or not the wetted materials in the integrated rack systems connected to the LTL or MTL contain aluminum alloys or alloys with greater than 5% copper. Verification shall be considered successful when the analysis shows the integrated rack systems connected to the LTL or MTL wetted materials do not contain aluminum alloys nor alloys with greater than 5% copper.

C. Verification that integrated rack system's non–metallic wetted surfaces are composed of materials that are non–nutrient to fungal growth inside the LTL and MTL systems shall be by analysis or test. An analysis shall review MIL–STD–454 to determine whether or not the non–metal materials used in the integrated rack systems connected to the LTL or MTL support fungal growth. Or, a test shall be conducted in accordance wit MIL–STD–810, method 508, to determine whether or not the non–metallic materials support fungal growth. Verification shall be considered successful when the analysis or test shows the non–metallic wetted materials used in the integrated rack systems connected to the LTL or MTL are non–nutrient to fungal growth.

4.3.11.3 CLEANLINESS

Verification that integrated racks conform to Visibly Clean-Sensitive (VC–S) cleanliness requirements as specified in SN–C–0005 shall be by inspection. An inspection of the cleanliness documentation required by precision cleaning shall be performed to show that each part, component, subsystem and system of the end product meets the VC–S requirement. Verification shall be considered successful when the inspection shows that each part, component, subsystem and system of the end product meets the VC–S requirement.

4.3.11.4 FUNGUS RESISTANT MATERIAL

Verification that integrated racks that are intended to remain on-orbit for more than one (1) year use fungus resistant materials according to the requirements in SSP 30233, paragraph 4.2.10 shall be by inspection. Inspection of design drawings and materials lists shall determine whether fungus resistant materials have been used as required. Verification shall be considered successful when the inspection shows fungus resistant materials are used as required.

4.3.11.5 PYROTECHNICS

NVR

4.3.12 HUMAN FACTORS INTERFACE REQUIREMENTS

The Human Factors Implementation Team (HFIT) has been established as an optional service to perform the necessary verification activities (analysis, test, inspection or demonstration) for the International Space Station (ISS) Payload Developers (or facility Payload Integrator, as applicable) to certify that the payload hardware meets Space Station Program (SSP) 57000 section 3.12 requirements with the exception of sections 3.12.3.2, Touch Temperature, inclusive of all subsections, and 3.12.3.3, Acoustic Requirements, inclusive of all subsections. Appendix F to this document provides instructions for utilizing the HFIT for verification of the Human Factor requirements.

4.3.12.1 STRENGTH REQUIREMENTS

A. Normal Operations:

(1) Grip strength shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the grip strength required to remove, replace and operate the integrated rack equipment is as specified.

(2) Linear forces shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the linear forces required to remove, replace and operate the integrated rack equipment is as specified.

(3) Torsional forces shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the torsional forces required to remove, replace and operate the integrated rack equipment is as specified.

B. Maintenance Operations:

Forces shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the strength values required to perform maintenance operations on the integrated rack equipment is as specified.

4.3.12.2 BODY ENVELOPE AND REACH ACCESSIBILITY

4.3.12.2.1 ADEQUATE CLEARANCE

The integrated rack clearance shall be verified by analysis or demonstration. The analysis shall be based on an evaluation of the drawing(s) with the clearance requirements to perform the tasks using the tools and equipment utilized in payload installation, operations, and maintenance. The demonstration shall be performed on the flight hardware or hardware which replicates the flight hardware configuration with the tools and equipment utilized in payload installation, operations, and maintenance. The verification shall be considered successful when the analysis or demonstration shows that the clearance accommodates crew performance of tasks, including tool utilization, and is sufficient to install/de-install, replace, operate and maintain the integrated rack equipment.

4.3.12.2.2 ACCESSIBILITY

A. Payload hardware accessibility shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the specified accessibility is sufficient to remove, replace, operate and maintain the integrated rack equipment.

B. IVA clearances shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows the specified IVA clearances.

4.3.12.2.3 FULL SIZE RANGE ACCOMMODATION

Analyses of end item drawings that contain on-orbit crew interfaces shall be performed to verify that Payload hardware accommodates the 5th percentile Japanese female to the 95th percentile American male size measurements, estimated for the year 2000, as specified in SSP 50005, Anthropometric and Biomechanics Related Design data. Drawings of workstations and hardware having crew nominal operations and planned maintenance shall be analyzed to verify that they are sized to meet the functional reach limits for the 5th percentile Japanese female. Drawings of workstations and hardware having crew nominal operations and planned maintenance shall be analyzed to verify that they are sized to not confine the body envelope of the 95th percentile American male.

4.3.12.3 HABITABILITY

4.3.12.3.1 HOUSEKEEPING

4.3.12.3.1.1 CLOSURES OR COVERS

Design of closures or covers shall be verified by inspection of the integrated rack drawings. Verification shall be considered successful when inspection of the flight hardware confirms compliance with the requirement.

4.3.12.3.1.2 BUILT-IN CONTROL

A. Design of built-in controls shall be verified by inspection of the integrated rack drawings. Verification shall be considered successful when inspection of the flight hardware confirms compliance with the requirement.

B. Crew access to capture elements shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the crew can access the flight hardware capture elements for cleaning or replacement without dispersion of trapped material.

4.3.12.3.1.3 DELETED

4.3.12.3.1.4 DELETED

4.3.12.3.1.5 ONE-HANDED OPERATION

Verify by demonstration that cleaning equipment and supplies can be operated using only hand.

4.3.12.3.2 TOUCH TEMPERATURE

Verification of this requirement shall be performed and submitted to the PSRP in accordance with NSTS 13830 Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.12.3.2.1 CONTINUOUS/INCIDENTAL CONTACT – HIGH TEMPERATURE

Reference paragraph 4.3.12.3.2

4.3.12.3.2.2 CONTINUOUS/INCIDENTAL CONTACT – LOW TEMPERATURE

Reference paragraph 4.3.12.3.2

4.3.12.3.3 ACOUSTIC REQUIREMENTS

NVR

4.3.12.3.3.1 CONTINUOUS NOISE LIMITS

A. **Integrated Rack Whose Sub–Rack Equipment Will Not Be Changed Out** – Verification of Continuous Noise Sources (See Glossary of Terms) for integrated racks whose sub-rack equipment will not be changed out shall be performed by test.

Sound Pressure Level (SPL) test measurements shall be made at 0.6 meters for all sides of the integrated rack using the actual flight equipment (each serialized unit) even though prototype or qualification units may have been tested previously. The test configuration shall include any adjunct equipment, such as integrated rack-provided external computers, fans, etc., added in support of the rack system. The SPL test shall use Type 1 Sound Level

Meter (SLM) in accordance with ANSI S1.43–1997, “Specifications for Integrating–Averaging Sound Level Meters”, ANSI S1.4A–1985 “Specification for Sound Level Meters”, or IEC 61672–1, “Electroacoustics – Sound Level Meters – Part 1: Specifications.” The preferred instrument for acoustic verification is the Type 1 integrating–averaging sound level meter. This meter can either be of the handheld or component system variety.

Octave band filters used for verification measurements will at least meet the Order 3, Type 1–D specifications in accordance with ANSI S1.11–1986 (ASA 65–1986), “Specification for Octave–Band and Fractional–Octave Band Analog and Digital Filters” or meet the Class 1 specifications in accordance with IEC 1260–1995, “Electroacoustics–Octave–Band and Fractional–Octave–Band Filters” over the frequency range required for verification.

The SPL shall be measured at the loudest location 0.6 meters from the equipment surface in each of eight octave bands: 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz.

The verification shall be considered successful when the test shows the loudest noise location exposed directly to the habitable volume on the integrated rack SPL is at or below the levels specified in Table 3.12.3.3.1–1.

B. **Integrated Racks Whose Sub–Rack Equipment Will Be Changed Out** – Verification of Continuous Noise Sources (See Glossary of Terms) for integrated racks whose sub-rack equipment will be changed out, shall be verified using a test-correlated analytical model, or some other method approved and documented in the Acoustics Noise Control Plan section of the unique Payload Verification Plan (PVP). The analytical model shall include system noise sources and anticipated sub-rack payload complement noise sources. The test-correlated model process is shown in Figure 4.3.12.3.3.1–1.

The verification shall be considered successful when the results from the test-correlated analytical model predicts the loudest location 0.6 meters from the rack surface exposed to the crew habitable volume, in each of the eight octave bands defined in Table 3.12.3.3.1–1, to be at or below the levels specified in Table 3.12.3.3.1–1 for additions, deletions or configuration changes to any sub-rack equipment within the integrated rack.

C. **Independently Operated Equipment** – Verification of Continuous Noise Sources (See Glossary of Terms) for independently operated equipment shall be performed by test.

Sound Pressure Level (SPL) test measurements shall be obtained at 0.6 meters from all sides of the equipment. The SPL test shall use a Type 1 Sound Level Meter (SLM) in accordance with ANSI S1.43–1997, “Specifications for Integrating–Averaging Sound Level Meters”, ANSI S1.4A–1985 “Specifications for Sound Level Meters”, or IEC 61672–1, “Electroacoustics–Sound Level Meters–Part 1: Specifications.” The preferred instrument for acoustic verification is the Type 1 integrating–averaging sound level meter. This meter can either be of the handheld or component system variety.

The SPL shall be measured in each of eight octave bands: 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz.

Octave band filters used for verification measurements will at least meet the Order 3, Type 1–D specifications in accordance with ANSI S1.11–1986 (ASA 65–1986), “Specification for Octave–Band and Fractional–Octave Band Analog and Digital Filters” or meet the Class 1 specifications in accordance with IEC 1260–1995, “Electroacoustics–Octave–Band and Fractional–Octave–Band Filters” over the frequency range required for verification.

The verification shall be considered successful when the test shows the equipment SPL noise level is at or below the levels specified in Table 3.12.3.3.1–2.

D. **Integrated Racks that Have Crew Operations Within the Rack Volume** – Verification of integrated racks that have crew operations within the rack's internal volume shall be performed by test, unless it is expected that the sub–rack equipment will be changed out. In that case, verification of integrated racks that have crew operations within the rack's internal

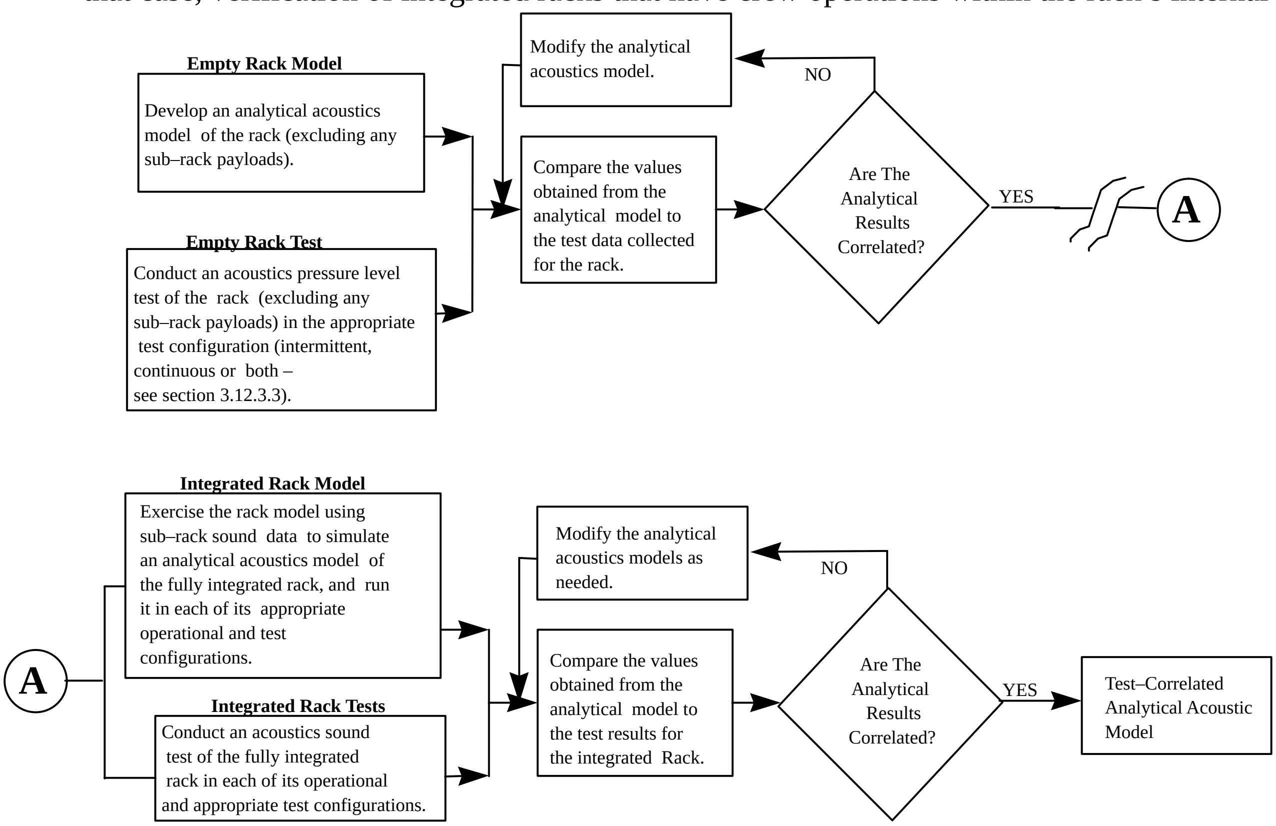

FIGURE 4.3.12.3.3.1–1 TEST-CORRELATED MODEL PROCESS

volume shall be performed using a test–correlated model or some other method approved and documented in the Acoustics Noise Control Plan section of the unique Payload Verification Plan (PVP). The analytical model shall include the worst case noise sources from any operating payload equipment and from any adjoining racks. Note: If adjacent rack noise data is not available, a continuous NC–45 noise level should be used.

In addition to the verification requirements of paragraph 4.3.12.3.3.1 (A) and (B), the verification shall be considered successful when the results from the test, test–correlated analytical model, or some other method approved and documented in the Acoustics Noise Control Plan section of the unique Payload Verification Plan (PVP), predicts the loudest noise produced at the expected position of 95% American male and 5% Japanese female's head during nominal payload operations to be at or below the levels specified in SSP 57000 Table 3.12.3.3.1–3.

4.3.12.3.3.2 INTERMITTENT NOISE LIMITS

A. **Integrated Racks That Do Not Have Crew Operations Within the Rack Volume** – Verification of Intermittent Noise Sources (See Glossary of Terms) for integrated racks whose sub-rack equipment will not be changed out shall be performed by test.

Sound Pressure Level (SPL) test measurements shall be obtained for the integrated rack. The test configuration shall include any adjunct equipment, such as integrated rack-provided external computers, fans, etc., added in support of the rack system. The SPL test shall use a Type 1 Sound Level Meter (SLM) in accordance with ANSI S1.43–1997, "Specifications for Integrating–Averaging Sound Level Meters", ANSI S1.4A–1985 "Specifications for Sound Level Meters", or IEC 61672–1, "Electroacoustics – Sound Level Meters – Part 1: Specifications". The preferred instrument for acoustic verification is the Type 1 integrating–averaging sound level meter. This meter can either be of the handheld or component system variety.

The SPL test shall quantify the intermittent noise characteristics in terms of:

(1) when the intermittent sound occurs (a description of what payload activities/operations produce intermittent sound), i.e. a compressor turning on

(2) duration and SPL (maximum A-weighted SPL measured at 0.6 meter distance from the loudest part of the equipment)

(3) a projected mission timeline(s) (a typical payload scenario that would produce intermittent sound)

The verification shall be considered successful when the test shows the integrated rack A-weighted SPL (dBA) is at or below the levels specified in Table 3.12.3.3.2–1.

Verification of Intermittent Noise Sources (See Glossary of Terms) for integrated racks whose sub-rack equipment will be changed out shall be performed using a test-correlated analytical model, or some other method approved and documented in the Acoustics Noise Control Plan section of the unique Payload Verification Plan (PVP)

A test-correlated model as depicted in Figure 4.3.12.3.3.1–1, or other approved verification method for the integrated rack for Maximum Rack Noise Duration as defined in Table 3.12.3.3.2–1, shall be used to perform integrated rack analysis. The analysis shall exercise the test-correlated model for every intermittent noise occurrence and quantify the noise characteristics in terms of:

(1) when the intermittent sound occurs (a description of what payload activities/operations produce intermittent sound), i.e. a compressor turning on

(2) duration and SPL (maximum A-weighted SPL measured at 0.6 meter distance from the loudest part of the equipment)

(3) a projected mission timeline(s) (a typical payload scenario that would produce intermittent sound)

The verification shall be considered successful when the results from the test-correlated analytical model predicts the A-weighted noise level of the integrated rack for the Maximum Rack Noise Duration to be at or below the levels specified in Table 3.12.3.3.2–1.

B. **Integrated Racks That Have Crew Operations Within the Rack Volume** – Verification of integrated racks that have crew operations within the rack's internal volume shall be performed by test, unless it is expected that the sub–rack equipment will be changed out. In that case verification of integrated racks which have crew operations within the rack's internal volume shall be performed using a test–correlated model or some other method approved and documented in the Acoustics Noise Control Plan section of the unique Payload Verification Plan (PVP). The test–correlated model process is shown in Figure 4.3.12.3.3.1–1. The analytical model shall include the worst case noise sources from any operating payload equipment and from any adjoining racks. Note: If adjacent rack noise data is not available, a continuous NC–45 noise level should be used.

In addition to the verification requirements in paragraph 4.3.12.3.3.2 (A), the verification shall be considered successful when the results from the test, test–correlated analytical model, or some other method approved and documented in the Acoustics Noise Control Plan section of the unique Payload Verification Plan (PVC), predicts the loudest noise produced at the expected position of a 95% American male and 5% Japanese female's head during nominal payload operations to be at or below the levels specified in SSP 57000 Table 3.12.3.3.2–2.

4.3.12.3.4 LIGHTING DESIGN

A. Verification of the specularity of the total work surface reflection shall be by testing or inspection. The testing shall be considered successful when the specularity of the total work surface reflection does not exceed 20 percent. The inspection shall be considered successful if the work space surface uses paint(s) selected from Table 3.12.3.4–1.

B. The task illumination level identified in Table 3.12.3.4–2 shall be verified by test. The test shall be considered successful when illumination level as identified in Table 3.12.3.4–2 measured at the task site(s) is met. The illumination level in a glovebox payload shall be determined by taking the average of a minimum of nine measurements (3–by–3 matrix) equally spaced encompassing the base of the work area surface.

C. Verification of a dimmable light source shall be by demonstration. The demonstration shall be considered successful when the light source is demonstrated to be continuously adjustable between 0 (off) and 100 percent (on) output.

D. Verification of the brightness ratio in a glovebox shall be by demonstration. The demonstration shall be considered successful when the minimum to maximum illumination levels, taken from the nine measurements in item B, does not exceed a brightness ratio of 3:1.

E. The use of the PUL for medium payload operational tasks shall be verified by analysis or test. The analysis or test shall show the PUL placed in a configuration that provides the required level of illumination at the task site. The analysis or test shall be considered successful when it shows that the payload is designed to use the PUL for all medium payload operational tasks.

4.3.12.4 STRUCTURAL/MECHANICAL INTERFACES

4.3.12.4.1 DELETED

4.3.12.4.2 PAYLOAD HARDWARE MOUNTING

4.3.12.4.2.1 EQUIPMENT MOUNTING

Equipment mounting used during nominal operations and planned maintenance shall be verified by analysis or demonstration. The verification shall be considered successful when the analysis or demonstration shows that the payload hardware used during nominal operations and planned maintenance is designed, labeled, or marked to protect against improper installation.

4.3.12.4.2.2 DRAWERS AND HINGED PANELS

Drawers and hinged panels shall be verified by analyses. Verification shall be considered successful when an analysis of the equipment flight drawings shows that any payload ORU that has to be removed is mounted on equipment drawers or hinged panels, and remains in the open position without being supported by the hand.

4.3.12.4.2.3 DELETED

4.3.12.4.2.4 DELETED

4.3.12.4.2.5 ALIGNMENT

Alignment shall be verified by analysis. Verification shall be considered successful when an analysis of the payload flight hardware drawings shows that guide pins or their equivalent are provided to assist in alignment during installation of hardware with blind mate connectors.

4.3.12.4.2.6 SLIDE-OUT STOPS

Slide-out stops shall be verified by inspection, analysis or demonstration. Verification shall be considered successful when an inspection or analysis of the drawings or demonstration of the payload flight hardware shows that limit stops are provided on slide or pivot mounted sub-rack hardware which is required to be pulled out of its installed positions.

4.3.12.4.2.7 PUSH-PULL FORCES

Push-Pull forces shall be verified by analysis. Verification shall be considered successful when an analysis of the payload flight hardware shows that hardware mounted into a capture-type receptacle that requires push-pull action requires a force less than 156 N to install and remove.

4.3.12.4.2.8 ACCESS

Access to inspect or replace a hardware item which is planned to be accessed on a daily or weekly basis shall be verified by analysis or demonstration. Verification shall be considered successful when an analysis of the payload flight hardware drawings or a demonstration of the payload flight hardware shows that hardware items which are planned to be accessed on a daily or weekly basis can be inspected and replaced without requiring the removal of an ORU or more than one access cover.

4.3.12.4.2.8.1 COVERS

The following verification requirements apply to paragraph 3.12.4.2.8.1A and B.

An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows the requirement has been met.

4.3.12.4.2.8.2 SELF-SUPPORTING COVERS

Self-supporting covers shall be verified by analysis. Verification shall be considered successful when an analysis of the payload flight hardware drawings shows that all access covers that are not completely removable are self-supporting in the open position.

4.3.12.4.2.8.3 DELETED

4.3.12.4.2.8.4 UNIQUE TOOLS

Unique tools shall be verified by analysis. Verification shall be considered successful when an analysis of the payload flight hardware drawings meet the requirements of 50005, paragraph 11.2.3.

4.3.12.4.3 CONNECTORS

4.3.12.4.3.1 ONE-HANDED OPERATION

One-handed operation shall be verified by analysis or demonstration. The analysis or demonstration shall be performed on the drawings or flight hardware which replicates the flight configuration. Verification shall be considered successful when the analysis or demonstration shows the all connectors can be mated/demated using only one hand, which does not preclude the use of either hand.

4.3.12.4.3.2 ACCESSIBILITY

A.

(1) Nominal Operations – Accessibility shall be verified by analysis or demonstration. Verification shall be considered successful when an analysis of the payload flight hardware drawings or demonstration of the payload flight hardware shows that it is possible to mate/demate individual connectors without having to remove or mate/demate other connectors.

(2) Maintenance Operations – Accessibility shall be verified by analysis or demonstration. Verification shall be considered successful when an analysis of the payload flight hardware drawings or demonstration of the payload flight hardware

shows that it is possible to mate/demate individual connectors without having to remove or mate/demate connectors on other ORUs or payloads.

B. Accessibility shall be verified by analysis. Verification shall be considered successful when an analysis of the payload hardware drawings shows that it is possible to disconnect and reconnect electrical connectors and cable installations without damage to wiring connectors.

4.3.12.4.3.3 EASE OF DISCONNECT

A. Ease of disconnect shall be verified by analysis. Verification shall be considered successful when the analysis shows that electrical connectors which are mated/demated during nominal operations, require no more than two turns to disconnect.

B. Ease of disconnect shall be verified by analysis. Verification shall be considered successful when the analysis shows that electrical connectors which are mated/demated during ORU replacement operations require no more than six turns to disconnect.

4.3.12.4.3.4 INDICATION OF PRESSURE/FLOW

Indication of pressure flow shall be verified by analysis. Verification shall be considered successful when analysis of payload flight hardware drawings shows that payload liquid or gas lines not equipped with quick disconnect connectors which are designed to be connected/disconnected under pressure are fitted with pressure/flow indicators.

4.3.12.4.3.5 SELF LOCKING

Self locking shall be verified by analysis. Verification shall be considered successful when an analysis of payload flight hardware drawings shows payload electrical connectors are provided with a self-locking feature.

4.3.12.4.3.6 CONNECTOR ARRANGEMENT

A. Connector arrangement shall be verified by inspection. Verification shall be considered successful when an inspection of the space between connectors and adjacent obstructions comply with the requirement.

B. Connector arrangement shall be verified by inspection. Verification shall be considered successful when an inspection of connectors in a single row or staggered rows comply with the requirements.

4.3.12.4.3.7 ARC CONTAINMENT

Arc Containment shall be verified by analysis. Verification shall be considered successful when an analysis of the payload flight hardware drawings shows that electrical connector plugs confine/isolate the mate/demate electrical arcs or sparks.

4.3.12.4.3.8 CONNECTOR PROTECTION

Connector protection shall be verified by analysis. Verification shall be considered successful when an analysis shows that protection is provided for all demated connectors against physical damage and contamination.

4.3.12.4.3.9 CONNECTOR SHAPE

Connector shape shall be verified by analysis. Verification shall be considered successful when an analysis of payload flight hardware drawings shows that connectors which differ in content are of different shape or are physically incompatible.

4.3.12.4.3.10 FLUID AND GAS LINE CONNECTORS

The inspection of fluid and gas line connectors that are mated and demated on-orbit shall be verified by analysis. Verification shall be considered successful when an analysis of payload flight hardware drawings shows that fluid and gas connectors that are mated and demated on-orbit are located and configured so that they can be fully inspected for leakage.

4.3.12.4.3.11 ALIGNMENT MARKS OR GUIDE PINS

Alignment marks or guide pins on mating parts shall be verified by inspection. Verification shall be considered successful when an inspection shows that mating parts have alignment marks in a visible location during mating or guide pins (or their equivalent).

4.3.12.4.3.12 CODING

A. Coding shall be verified by inspection. Verification shall be considered successful when an inspection shows that both halves of mating connectors display a code or identifier which is unique to that connection.

B. Coding shall be verified by inspection. Verification shall be considered successful when an inspection shows that labels or codes on connectors are visible when connected or disconnected.

4.3.12.4.3.13 PIN IDENTIFICATION

Pin identification shall be verified by inspection. Verification shall be considered successful when an inspection shows that each pin is uniquely identified.

4.3.12.4.3.14 ORIENTATION

Orientation shall be verified by analysis. Verification shall be considered successful when an analysis of the payload flight hardware drawings shows that grouped plugs and receptacles are oriented so that the aligning pins or equivalent devices are in the same relative position.

4.3.12.4.3.15 HOSE/CABLE RESTRAINTS

A. Hose/Cable restraints shall be verified by inspection. Verification shall be considered successful when an inspection shows that the loose ends of hoses and cables have a means of being restrained.

B. Hose/Cable restraints shall be verified by inspection. Verification shall be considered successful when an inspection shows that conductors, bundles, or cables are secured by a means of clamps unless they are contained in wiring ducts or cable retractors.

C. NVR

D. Hose/Cable restraints shall be verified by inspection. Verification shall be considered successful when an inspection shows that loose cables are restrained as specified.

4.3.12.4.4 FASTENERS

4.3.12.4.4.1 NON-THREADED FASTENERS STATUS INDICATION

Non-threaded Fasteners Status indication shall be verified by demonstration or inspection. Verification shall be considered successful when demonstration or inspection shows that an indication of correct engagement (hooking, latch fastening, or proper positioning of interfacing parts) of non-threaded fasteners shall be provided.

4.3.12.4.4.2 MOUNTING BOLT/FASTENER SPACING

Mounting bolt/fastener spacing shall be verified by inspection. Verification shall be considered successful when an inspection shows that mounting bolts and fasteners are spaced as specified.

4.3.12.4.4.3 DELETED

4.3.12.4.4.4 MULTIPLE FASTENERS

Multiple fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that when several fasteners are used on one item they are all of identical type.

4.3.12.4.4.5 CAPTIVE FASTENERS

Captive fasteners shall be verified by analysis. Verification shall be considered successful when an analysis shows that fasteners planned to be installed and/or removed on-orbit are captive when disengaged.

4.3.12.4.4.6 QUICK RELEASE FASTENERS

A. Quick release fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that fasteners require a maximum of one complete turn to operate.

B. Quick release fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that fasteners are positive locking in open and closed positions.

4.3.12.4.4.7 THREADED FASTENERS

Threaded fasteners shall be verified by inspection. The inspection shall be of the drawings. Verification shall be considered successful when the inspection shows that all threaded fasteners are right handed.

4.3.12.4.4.8 OVER CENTER LATCHES

A. Over center latches shall be verified by inspection. Verification shall be considered successful when an inspection shows that there is a provision to prevent undesired latch element realignment, interface, or reengagement.

B. Over center latches shall be verified by inspection. Verification shall be considered successful when an inspection shows that latch catches have a locking features.

C. Over center latches shall be verified by inspection. Verification shall be considered successful when an inspection shows that the latch handle and latch release are operable by one hand.

4.3.12.4.4.9 WINGHEAD FASTENERS

Winghead fasteners shall be verified by inspection. Verification shall be considered successful when an inspection shows that fold and are retained flush with surfaces.

4.3.12.4.4.10 DELETED

4.3.12.4.4.11 FASTENER HEAD TYPE

A. The hex type external or internal grip or combination head fastener type shall be verified by inspection. The inspection shall be of the hardware or the drawings and parts list. Verification shall be considered successful when an inspection shows that the hex type external or internal grip or combination head fasteners are used for all on-orbit crew actuated equipment.

B. The use flush or oval head internal hex grip fastener head type on smooth surfaces shall be verified by inspection. The inspection shall be of the hardware or the drawings and parts list. Verification shall be considered successful when an inspection shows that, when a smooth surface is required, only flush or oval head internal hex grip fastener head types are used.

C. The verification that straight-slot fasteners are not used to carry launch loads for hard-mounted equipment shall be by inspection. The inspection shall be of the hardware or the drawings and parts list. Verification shall be considered successful when an inspection shows that straight-slot fasteners are not being used to carry launch loads for hard-mounted equipment.

4.3.12.4.4.12 ONE-HANDED ACTUATION

One handed operation shall be verified by analysis or demonstration. The analysis or demonstration shall be performed on the drawings or flight hardware or hardware which replicates the flight hardware configuration. Verification shall be considered successful when the demonstration shows that fasteners planned to be removed or installed on-orbit can be mated/demated using only one hand, which does not preclude the use of either hand.

4.3.12.4.4.13 DELETED

4.3.12.4.4.14 ACCESS HOLES

Access holes shall be verified by inspection. Verification shall be considered successful when an inspection shows that covers or shields through which mounting fasteners must pass for attachment to the basic chassis of the unit shall have holes for passage of the fastener without precise alignment .

4.3.12.5 CONTROLS AND DISPLAYS

4.3.12.5.1 CONTROLS SPACING DESIGN REQUIREMENTS

Controls spacing design shall be verified by inspection. Verification shall be considered successful when the spacing between controls and adjacent obstructions is as specified.

4.3.12.5.2 ACCIDENTAL ACTUATION

4.3.12.5.2.1 PROTECTIVE METHODS

Protective methods to reduce accidental actuation of controls shall be verified by inspection. Verification shall be considered successful when one or more of the conditions called out in sub–paragraphs A through G of paragraph 3.12.5.2.1 are met.

4.3.12.5.2.2 NONINTERFERENCE

Noninterference shall be verified by inspection. Verification shall be considered successful when an inspection shows that protection devices do not cover or obscure other displays and controls.

4.3.12.5.2.3 DEAD-MAN CONTROLS

NVR

4.3.12.5.2.4 BARRIER GUARDS

Barrier guards shall be verified by inspection. Verification shall be considered successful when an inspection shows that the barrier guard spacing is as specified.

4.3.12.5.2.5 RECESSED SWITCH PROTECTION

Recessed switch protection shall be verified by inspection. Verification shall be considered successful when an inspection shows that rotary switches that control critical functions, and do not have a barrier guard, are recessed as specified.

4.3.12.5.2.6 DELETED

4.3.12.5.2.7 POSITION INDICATION

Position indication shall be verified by inspection. Verification shall be considered successful when an inspection shows that control position is evident without requiring cover removal.

4.3.12.5.2.8 HIDDEN CONTROLS

Hidden controls shall be verified by inspection. Verification shall be considered successful when an inspection shows that hidden controls are guarded to protect against inadvertent actuation.

4.3.12.5.2.9 HAND CONTROLLERS

Hand controllers shall be verified by inspection. Verification shall be considered successful when an inspection shows that hand controllers have a separate on/off control.

4.3.12.5.3 VALVE CONTROLS

A. Low-torque valve controls shall be verified by inspection. Verification shall be considered successful when an inspection of the payload flight hardware drawings of valves classified as low-torque are equipped with a central pivot type handle as specified.

B. Intermediate-torque valve controls shall be verified by inspection. Verification shall be considered successful when an inspection of the payload flight hardware drawings of valves classified as intermediate-torque are equipped with a central pivot or lever type handle as specified.

C. High-torque valve controls shall be verified by inspection. Verification shall be considered successful when an inspection of the payload flight hardware drawings of valves classified as high-torque valves are equipped with a lever type handle as specified.

D. Handle dimensions shall be verified by inspection. Verification shall be considered successful when an inspection of payload flight hardware drawings is as specified.

E. Rotary valve controls shall be verified by inspection. Verification shall be considered successful when an inspection shows that rotary valve controls open the valve with a counter-clockwise motion.

4.3.12.5.4 TOGGLE SWITCHES

Toggle switches shall be verified by inspection. Verification shall be considered successful when an inspection of the flight article drawings is as specified.

4.3.12.6 RESTRAINTS AND MOBILITY AIDS

The design of the integrated rack shall be verified by demonstration or analysis. Verification shall be considered successful when the payload rack installation, operation, and maintenance tasks can be performed using standard crew restraints, mobility aids, and interfaces as specified. The demonstration or analysis shall show adequate clearance for attaching RMAs in a position that 95% and 5% crew can reach and is oriented to perform the installation, operation, and maintenance tasks.

4.3.12.6.1 STOWAGE DRAWER CONTENTS RESTRAINTS

A. The payload drawer/tray contents restraints shall be verified by inspection and analysis. The inspection and analysis shall be of the drawings of the flight hardware or hardware which replicates the flight hardware configuration. Verification shall be considered successful when the inspection and analysis shows that all items in a drawer/tray are restrained in a manner to prevent floating when the drawer is opened or closed.

B. The payload drawer/tray contents will be verified by demonstration. The demonstration shall be performed on the flight hardware or hardware which replicates the flight hardware configuration. Verification shall be considered successful when a demonstration shows that the restrained payload drawer/tray contents (including the restraints mentioned in 4.3.12.6.1, A) do not jam the drawer when the drawer is opened or closed.

C. The restraints for the payload drawer/tray contents shall be verified by demonstration. The demonstration shall be performed on the flight hardware or hardware which replicates the flight hardware configuration. The verification shall be considered successful when the demonstration shows that the contents of the payload drawer/tray can be removed and/or replaced without using a tool.

4.3.12.6.2 STOWAGE AND EQUIPMENT DRAWERS/TRAYS

A. Verification of stowage equipment drawers/trays shall be done by inspection. Verification shall be considered successful when an inspection of the payload flight hardware drawings shows that all latches, handles, and operating mechanisms are designed to be latched/unlatched and opened/closed with one hand by the 95th percentile American male and accommodate the 5th percentile female.

B. Verification of stowage and equipment drawers/trays shall be done by inspection. Verification shall be considered successful when an inspection shows that latches shall be such that their status can be determined through visual inspection.

4.3.12.6.3 CAPTIVE PARTS

Captive parts shall be verified by inspection. Verification shall be considered successful when an inspection shows that all unrestrained parts that are temporarily removed on orbit are held captive.

4.3.12.6.4 HANDLE AND GRASP AREA DESIGN REQUIREMENTS

4.3.12.6.4.1 HANDLES AND RESTRAINTS

Verification of portable equipment grasp capability shall be by demonstration or inspection. The demonstration shall utilize personnel with hand dimensions within 10% of Table 3.12.6.4.1–1 to demonstrate sufficient grasp capability is provided for the 5th percentile Japanese female and 95th percentile American male. The inspection shall utilize drawings to verify that a handle or other suitable grasp area is provided for portable equipment. The demonstration or inspection shall be considered successful when it is shown that the portable equipment can be grasped by both 5th percentile Japanese female and 95th percentile American male personnel using one hand, and the item is larger than 1 ft^3.

4.3.12.6.4.2 DELETED

4.3.12.6.4.3 HANDLE LOCATION/FRONT ACCESS

Handle location and access requirements shall be verified by inspection of the integrated rack drawings. Verification shall be considered successful when inspection of the flight hardware confirms compliance with the requirement.

4.3.12.6.4.4 HANDLE DIMENSIONS

IVA handle dimensions for moveable or portable units shall be verified by analysis or demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirements.

4.3.12.6.4.5 NON-FIXED HANDLES DESIGN REQUIREMENTS

A. Nonfixed handle stop position shall be verified by analysis and demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirement.

B. Verification of one-handed operation shall be done by demonstration. The verification shall be considered successful when demonstration of this requirement is met.

C. The incorporation of tactile and/or visual indication of locked/unlocked status shall be verified by inspection and demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirement.

4.3.12.7 IDENTIFICATION LABELING

Labels on integrated racks, all (installed in the rack or separately) sub–rack elements, loose equipment, consumables, ORUs, crew accessible connectors and cables, switches, indicators, and controls shall be verified by inspection. The inspection shall be of the IPLAT approval documentation. The verification shall be considered successful when integrated racks, all sub–rack elements, loose equipment, consumables, ORUs, (installed in the rack or separately); crew accessible connectors and cables, switches, indicators, and controls have been shown to have IPLAT approved labels. The instructions for IPLAT to follow in granting approval of labels are located in Appendix C.

4.3.12.8 COLOR

Interior colors and finishes documentation shall be inspected to verify that it follows the color coding scheme as specified in Table 3.12.3.4–1.

Color shall be verified by inspection. Verification shall be considered successful when an inspection shows that interior colors are as specified.

4.3.12.9 CREW SAFETY

Verification of this requirement shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.12.9.1 ELECTRICAL HAZARDS

4.3.12.9.1.1 MISMATCHED

The design of electrical connectors to preclude inadvertent reversal of connections shall be verified by analysis, inspection and demonstration. The verification shall be considered successful only when all of the integrated rack electrical connectors, and wire harnesses requiring crew access to mate/demate during on-orbit operations are demonstrated to meet the requirements.

4.3.12.9.1.2 DELETED

4.3.12.9.1.3 DELETED

4.3.12.9.1.4 OVERLOAD PROTECTION

NVR

4.3.12.9.1.4.1 DEVICE ACCESSIBILITY

Verification that an overload protective device will not be accessible without opening a door or cover (except operating handles or buttons of a circuit breaker, the cap of an extractor-type fuse holder, and similar parts may project outside the enclosure) shall be by hardware inspection. Verification shall be considered successful when hardware inspection shows a door or cover must be opened to access the overload protective device.

4.3.12.9.1.4.2 EXTRACTOR – TYPE FUSE HOLDER

Verification that the arrangement of the extractor–type fuse holder operates such that the fuse is extracted when the cap is removed shall be by demonstration. Verification shall be considered successful when demonstrations show the fuse is extracted when the removable cap assembly is removed.

4.3.12.9.1.4.3 OVERLOAD PROTECTION LOCATION

Verification that overload protection (fuses and circuit breakers) intended to be manually replaced or physically reset on–orbit are located where they can be seen and replaced or reset without removing other components shall be by hardware inspection. Verification shall be considered successful when hardware inspection results show that overload protection devices are directly visible and accessible without removal of other components.

4.3.12.9.1.4.4 OVERLOAD PROTECTION IDENTIFICATION

Verification that each overload protector (fuse or circuit breaker), intended to be manually replaced or physically reset on–orbit, shall be readily identified or keyed (mechanically or color coded) for its rated value shall be by hardware inspection. Verification shall be considered successful when hardware inspection results show the rated identification for each overload protection is in place.

4.3.12.9.1.4.5 AUTOMATIC RESTART PROTECTION

Verification shall be by demonstration. The demonstration shall first induce an "Overload Initiated Shutdown" as defined in SSP 57000 paragraph 3.2.2.6.1.1 and then observe system response to assure that Automatic Restart does not occur unless the Protection Switch/Control is explicitly operated to enable restarting. The verification of Automatic Restart Protection shall be considered successful when it shows that automatic restart cannot occur following an overload–initiated shutdown without explicit operation of the protection switch/control to enable restarting.

4.3.12.9.1.5 DELETED

4.3.12.9.1.5.1 DELETED

4.3.12.9.2 SHARP EDGES AND CORNERS PROTECTION

Verification that the hardware meets the sharp edges and corners requirements specified in NSTS 1700.7, ISS Addendum 222.1 shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when the hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.12.9.3 HOLES

An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify holes in IVA crewmember translation paths and maintenance worksites. A drawing inspection shall show that the proper hole sizes have been used or proper guards are in place. Verification shall be considered successful when analysis and inspection shows that all holes are of the proper size, covered, or guarded.

4.3.12.9.4 LATCHES

Verification shall be by inspection. The verification shall be considered successful when the inspection shows that all latches and similar devices have been properly covered, or guarded and designed to prevent entrapment of crew member appendages.

4.3.12.9.5 SCREWS AND BOLTS

Verification shall be by analysis and inspection. An analysis shall be performed using data from drawings, integration documentation, and operational procedures to identify screws and bolts which exceed the length specified in the requirements and the required use of guards or covers due to location in crewmember translation paths and maintenance worksites. A drawing inspection shall show that the required cover installation has been accomplished or proper guards are in place. Verification shall be considered successful when analysis and inspection shows that screws and bolts which exceed the specified length have been properly covered, or guarded.

4.3.12.9.6 SECURING PINS

An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows the requirement has been met.

4.3.12.9.7 LEVERS, CRANKS, HOOKS, AND CONTROLS

Verification shall be by analysis and inspection. The verification shall be considered successful when the inspection and analysis shows that all levers, cranks, hooks, and controls have been properly covered, or guarded and cannot pinch, snag, or cut, the crewmembers or their clothing.

4.3.12.9.8 BURRS

Verification shall be by inspection. The verification shall be considered successful when the inspection shows that all edges have been properly deburred.

4.3.12.9.9 LOCKING WIRES

A. An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows the requirement has been met.

B. An inspection of payload hardware or flight drawings shall be performed to verify compliance with the requirement. The verification shall be considered successful when the inspection shows the requirement has been met.

4.3.12.9.10 AUDIO DEVICES (DISPLAYS)

A. Verification that the audio devices and circuits protect against false alarm shall be by analysis. The verification shall be considered complete when analysis shows that protective measures have been taken.

B. Deleted.

C. Verification of circuit test devices or other means of operability testing shall be by demonstration. The requirement will be met when demonstration shows that the circuit test device correctly indicates when the audio device is working, and when it is not working.

D. Verification of the manual disable device shall be by analysis that determines whether any failure modes can result in sustained activation of the audio device. If no such failure mode exists, then further verification is not required. However, if analysis shows that there are failure modes that can result in sustained activation of the audio device, then demonstration of the manual disable mode shall be required. In that case, the requirement shall be considered successful when demonstration shows that the audio device can be manually turned off.

4.3.12.9.11 DELETED

4.3.12.9.12 EGRESS

Verification of this requirement shall be performed and submitted to the PSRP in accordance with NSTS 13830. Verification shall be considered successful when hazard reports and safety data presented to the PSRP during the phased safety reviews are approved.

4.3.12.9.13 LASERS

NVR

4.3.12.9.14 OPTICAL EQUIPMENT AND INSTRUMENTS

NVR

4.3.12.10 PAYLOAD IN-FLIGHT MAINTENANCE

An analysis of payload hardware and flight drawings shall be performed to verify requirement. The verification shall be considered successful when the analysis shows the requirement has been met.

APPENDIX A ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
AIT	Analysis and Integration Team
APM	Attached Pressurized Module
APS	Automated Payload Switch
ANCP	Acoustics Noise Control Plan
Ar	Argon
ARIS	Active Rack Isolation System
ASI	Italian Space Agency
ASTM	Americal Society for Testing and Materials
AWG	Americal Wire Gauge
BER	Bit Error Rate
BIT	Built In Test
BPDU	Bitstream Protocol Data Unit
C	Centigrade
cc	cubic centimeters
CCIR	International Radio Communication/Consulate Committee
cm	Centimeter
C&DH	Command & Data Handling
CCSDS	Consultative Committee for Space Data Systems
C&T	Communications & Tracking
C&W	Caution and Warning

CAM	Centrifuge Accommodations Module
CMG	Control Moment Gyroscope
CO_2	Carbon Dioxide
COF	Columbus Orbiting Facility
COTS	Commercial Off The Shelf
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CVIU	Common Video Interface Unit
DEAP	Dryden Early Access Platform
dB	deciBel
dBs	deciBels
dBA	Acoustic Decibel Level
dBm	deciBels Referenced to One Milliwatt
dc	Direct Current
EEE	Electrical, Electronic, and Electromechanical
EIA	Electronic Industries Association
ELM-PS	Experiment Logistics Module – Pressurized Section
EMC CS–01, 02	Electromagnetic Compatibility; Conducted Susceptibility –01 (CS–01), (CS–01), Conducted Susceptibility –02 (CS–02)
EMI	Electromagnetic Interference
EPCE	Electrical Power Consuming Equipment
EPS	Electrical Power System
ESA	European Space Agency
ESD	Electrostatic Discharge
EWACS	Emergency, Warning, Caution and Safety

F	Fahrenheit
FDDI	Fiber Optics Distribution Data Interface
FHP	First Header Pointer
FO	Fiber Optics
FSS	Fluid System Servicer
GFCI	Ground Fault Circuit Interrupter
GSE	Ground Support Equipment?
He	Helium
HRDL	High Rate Data Link
HRFM	High Rate Frame Multiplexer
hr	hour
Hz	Hertz
ICD	Interface Control Document
ICWG	Interface Control Working Group
IDD	Interface Design Document
IEC	International Electro Technical Commission
IEEE	Institute of Electrical and Electronic Engineers
I/F	Interface
IRD	Interface Requirements Document
IRE	Institute of Radio Engineers
ISO	International Standards Organization

ISPR	International Standard Payload Rack
ISS	International Space Station
ISSP	International Space Station Program
ITCS	Internal Thermal Control System
IVA	Intravehicular Activity
JEM	Japanese Experiment Module
kg	kilograms
kHz	kiloHertz
kPa	kiloPascal
KSC	Kennedy Space Center
kW	kiloWatt
LAB	Laboratory
LAN	Local Area Network
lbm	pounds mass
LED	Light Emitting Diode
LISN	Line Impedance Simulation Network
LLC	Logical Layer Control
LRDL	Low Rate Data Link
mA	milliAmperes
MATE III	Multiplexer/Demultiplexer Applications Test Environment
Mbps	MegaBytes per second

MDM	Multiplexer–Demultiplexer
MDP	Maximum Design Pressure
MEOP	Maximum Expected Operating Pressure
MHz	Megahertz
MIL–STD	Military Standard
MPICB	Multilateral Payload Implementation Control Board
MPLM	Multi–Purpose Logistics Module
MRB	Microgravity Rack Barrier
MRDL	Medium Rate Data Link (Ethernet)
ms	Millisecond
MSFC	Marshall Space Flight Center
MV	Millivolt
N	Newton
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NRZI	Non–Return to Zero Invert on Ones
NSTS	National Space Transportation System
NTSC	National Television Systems Committee
NVR	No Verification Required
ODS	Orbiter Docking System
ORU	Orbital Replacement Unit

Pa	Pascal
PCM	Program Cost Management
PCS	Portable Computer System
PDRT	Payload Display Review Team
PDU	Power Distribution Unit
PEHG	Payload Ethernet Hub Gateway
PFE	Portable Fire Extinguisher
PFM	Pulse Frequency Modulation
PG	Product Group
PIA	Payload Interface Agreement
PIDS	Prime Item Development Specification
PIO	Program Integration Office
PIRN	Preliminary/Proposed Interface Revision Notice
P/L	Payload
P/N	Part Number
PP	Pressurized Payloads
PRCU	Payload Rack Checkout Unit
psia	pounds per square inch absolute
PSRP	Payload Safety Review Panel
PUI	Program Unique Identifier
PUL	Portable Utility Light
QD	Quick Disconnect
R/FR	Refrigerator/Freezer

Rev	Revision
RHA	Rack Handling Adapter
RID	Rack Insertion Device
RMA	Restraint Mobility Aids
RMS	Root Mean Square
RPC	Remote Power Controller
RPCM	Remote Power Control Mechanism
RPCS	Remote Power Controllers
RSC	Rack Shipping Container
RT	Remote Terminal
RUP	Rack Utility Panels
RX	Reception
scc	Standard Cubic Centimeter
sec	second
SEE	Single Event Effect
SI	International System of Units
SLPM	Standard Liter Per Minute
SMAC	Spacecraft Maximum Allowable Concentrations
SPL	Sound Pressure Level
SPOE	Standard Payload Outfitting Equipment
SSCM	Space Station Change Memo
SSP	Space Station/Shuttle Program
SSPF	Space Station Processing Facility
SSQ	Space Station Qualified

STAA	Seat Track Adapter Assembly
SYNC	Synchronous
TAXI	Transparent Asynchronous Transmitter/Receiver Interface
TBC	To Be Confirmed
TBD	To Be Determined
TBE	Teledyne Brown Engineering
TBS	To Be Supplied
TBV	To be Verified
TCS	Thermal Control System
TIA	TV Industries Association
TM	Technical Memo
UIP	Utility Interface Panel
UOP	Utility Outlet Panel
USL	United States Laboratory
USOS	United States On–orbit Segment
V	Volt
VC–S	Visibly Clean – Sensitive
VES	Vacuum Exhaust System
VES/WGS	Vacuum Exhaust System and/or Waste Gas System
VRS	Vacuum Resource System
VSU	Video Switching Unit
WG	Waste Gas

WGS	Waste Gas System

APPENDIX B GLOSSARY OF TERMS

Access Port: Hole that allows penetration of the Portable Fire Extinguisher nozzle

Adjunct Active Portable Equipment: Equipment operated outside the rack required to support nominal payload operations (including any required GFE).

Acoustic Reference: All sound Pressure Levels in decibels are referenced to 20 micropascals.

Active Air Exchange: Forced convection between two volumes. For example, forced convection between a subrack payload the internal volume of an integrated rack, or forced convection between a subrack payload and the cabin air.

Aisle Mounted Equipment: Payloads and GFE that can not be packaged into an ISPR due to the nature of the equipment intended operations (i.e., laptop computers, crew exercise equipment, etc.). Aisle mounted equipment also includes non–ISPR payloads mounted in “open” rack locations (i.e., rack locations in which there is no rack installed) ventilated by the module ventilation system.

Alignment Marks: Are straight or curved lines of sufficient length and width to allow alignment, are applied to both mating parts, align when the parts are in the installation position, and are visible during alignment and attachment.

amu: One Atomic Mass Unit, equal to one–twelfth the mass of a carbon–12 atom, the average atomic mass is called the atomic weight.

Boss: Protruding hard–points for GSE attachment.

Brightness ratio: Defined as the ratio of the maximum light level on the work surface area to the minimum light level on the work surface area.

Catastrophic Hazard: Any hazard which causes loss of on-orbit life sustaining system function.

Common Mode Noise: Refer to SSP 30482

Continuous Noise Source: A significant noise source which exists for a cumulative total of eight hours or more in any 24-hour period is considered a continuous noise source.

Critical Hazard: Any hazard which may cause a non-disabling injury, severe occupational illness, loss of emergency procedures, or involves major damage to one of the following: the launch or servicing vehicle, manned base, an on-orbit life-sustaining function, a ground facility or any critical support facility.

Current Limiting: The current is limited to a specific level plus or minus a percentage for tolerance.

Detergent Wipes: Detergent–saturated tissues used for interior surfaces and window cleaning.

Disinfecting Wipes: Tissue saturated with a disinfecting cleansing agent or agents, for cleanup of biological spills and biologically contaminated surfaces.

Dry Wipes: Utility wipes used for compartment and equipment cleaning and spill clean–up.

Electromagnetic Compatibility (EMC): The capability of systems and all associated subsystems/equipment to perform within design limits without degradation due to the Electromagnetic Effect encountered during accomplishment of the assigned mission. The deliverable end item compatibility test is as described in paragraph 3.6.2 of SSP 30243.

Electromagnetic Interference (EMI): Any electromagnetic disturbance, phenomenon, signal, or emission (man–made or natural) which causes equipment performance outside of the equipment's design limits. Testing is as described in SSP 30237 and SSP 30238 as referenced by paragraph 3.2.4.4 of this IRD.

Emergency Condition: Toxic atmosphere, rapid cabin depressurization or fire.

EPCE: Equipment that consumes electrical power including battery powered equipment.

Fire Event: Localized or propagating combustion, pyrolysis, smoldering or other thermal degradation process characterized by the potentially hazardous release of energy, particulates, or gases.

GSE Plane: A reference plane that is defined by the front surface of the four rack GSE bosses.

Hazard: The presence of a potential risk situation caused by an unsafe act or condition.

Health and Status Data: Information originating at the payload and passed to the respective payload MDM that provides the crew and the ground confirmation of payload performance, operational state, resource consumption, and assurance that the payload is operating within the safety guidelines as defined by the Payload Safety Review Panel and the ISS Flight Rules. Some examples of payload health and status data are subsystem status (power, voltages, currents, temperatures, pressures, fluid flow velocities, warning indicators, error messages/codes, etc.), digital communications system statistics (1553, Ethernet, and high rate system status, etc.), and video system status (camera and video recorder on/off indications, Synchronization indicators, etc.).

Integrated Rack: The ISPR and all other sub–rack equipment which operates within a rack.

Intermittent Noise Source: A significant noise source which exists for a cumulative total of less than eight hours in a 24-hour period is considered an intermittent noise source.

Line Impedance Stabilization Network: An electrical circuit, including resistance, capacitance, and inductance, used to simulate a specific electrical power bus.

Narrow–band Disturbance Force: A narrow–band disturbance force is a force which peaks within frequency range.

Narrow–band Peak Enveloped Force Limit: The integrated rack microgravity disturbance allocation applicable to those one–third octave bands in which the peak power spectrum disturbance force at any frequency divided by the average disturbance force is greater than or equal to five.

Non–Normal: Pertaining to performance of the Electrical Power System outside the nominal design due to ISS system equipment failure, fault clearing, or overload conditions.

Non–Rack Payload: A pressurized payload which does not utilize an ISPR and has discrete physical interfaces to ISS services (i.e. power, data, video, vacuum, etc.)

On–Orbit Momentary Protrusions: Payload obstructions which typically would protrude for a very short time or could be readily eliminated by the crew at any time. Momentary protrusions includes only the following: drawer/door/cover replacement or closure.

On–Orbit Permanent Protrusion: A payload hardware item which is not ever intended to be removed.

On–Orbit Protrusions for Keep Alive Payloads: A protrusion which supports and/or provides the uninterrupted resources necessary to run an experiment. On–orbit protrusions for Keep Alive Payloads includes only power/data cables and thermal hoses.

On–Orbit Semi–permanent Protrusion: A payload hardware item which is typically left in place but can be removed by the crew with hand operations or standard IVA tools.

Example: SIR and ISIS drawer handles, other equipment that does not interfere with crew restraints & mobility aids.

On–Orbit Temporary Protrusion: A payload item which is typically located in the aisle for experiment purposes only. These items should be returned to their stowed configuration when not being used.

Example: Front panel mounted equipment

Operate: Perform intended design functions given specified conditions.

Patient: A crewmember instrumented with electrical/electronic equipment.

Potential Fire Event: A fire event that is detected by other means (e.g., temperature sensors, current sensors, etc.) than a certified Space Station smoke detector. Since, this alternate method can not confirm the presence of smoke with a confirmed redundant method like the certified Space Station smoke detector there is only a potential that a fire is occurring.

Potential Fire Source: Any electrical, chemical, or other energy source capable of creating a fire event (e.g., electrically powered equipment).

Protrusion: A payload hardware item which extends beyond the GSE plane.

Quasi–Steady Acceleration: ISS accelerations in the frequency range below 0.01 Hz. This limit is defined to be consistent with SSP 50036 so that the maximum average acceleration contribution from no integrated rack exceeds 0.02 micro–g continuously nor exceeds 10 micro–g seconds over any period of time not protected by the continuous limit.

Reusable Wipes: Utility handwipes that can be impregnated or dampened with premixed evaporative detergent/biocidal solutions or with water.

Safety–Critical: Having the potential to be hazardous to the safety of hardware, software, and personnel.

Specularity: Defined as the ratio of the flux leaving a surface or medium by regular (specular) reflection to the incident flux.

Standard Conditions: Measured volumes of gases are generally recalculated to 0°C temperature and 760 mm Hg pressure, which have been arbitrarily chosen as standard conditions.

vented conditions: Condition (Temperature and Pressure) of the gas in the experiment chamber as the chamber is opened to the ISS VES/WGS.

VES/WGS: Vacuum Exhaust System and/or Waste Gas System. The USL, JEM and APM each have similar systems to vent gases to space from an experiment chamber. The System in the USL is the Vacuum Exhaust System and the Systems in the JEM and APM are the Waste Gas Systems.

Wide–Band Disturbance Force A wide–band disturbance force is a force which occurs with uniform intensity over a frequency range.

Wide–Band Force Limit: The integrated–rack microgravity disturbance allocation applicable to those one–third octave bands in which the peak power spectrum disturbance force at any frequency divided by the average disturbance force within the band is less than five.

Wire derating: Wire is derated based on the current flow, environment, electrical circuitry that operates within an integrated rack or within electrical power consuming equipment individual boxes.

APPENDIX C INSTRUCTIONS FOR LABELS AND DECALS

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C.1 INTRODUCTION

The ISS Payload Label Approval Team (IPLAT) reviews and approves labels for all payload equipment that the crew will interface with during nominal operations, planned maintenance, and contingency operations. IPLAT does not approve Operations Nomenclature, procedures or displays. The Payload Operations Data File (PODF) group reviews and approves Operations Nomenclature and procedures. The Payload Display Review Panel (PDRP) reviews and approves all software displays. IPLAT, PODF and PDRT consult with one another regarding label issues that have implications for procedures and displays.

Appendix C provides the instructions for the approval of payload labels. The development of labels will be a joint process requiring the cooperative efforts of IPLAT and the PD. The process for developing labels, from the beginning to the delivery of flight certified labels which have been approved by the IPLAT, is documented in Figure C.1–1.

To understand the priorities of the instructions, the following definitions need to be applied throughout Appendix C.

Statements with “must” will be used for instructions which are required to be met for IPLAT to provide approval.

Statements with “should” will be used for instructions which are incorporated into the label unless adequate justification is provided to IPLAT to warrant exempting the label instruction.

The term “label” used throughout these instructions refers to any one of the following:

- Silk–screened labels: Markings that are silk–screened, with ink, onto hardware.
- Decals: Peel–off labels with adhesive backing that are applied onto hardware.
- Ink–stamped labels: Markings, stamped with ink, onto the hardware.
- Engraved or Etched labels: Markings carved onto the hardware surface.
- Placards: Cards which are inserted into pockets.
- Any other method of applying markings onto hardware.

SSP 50005, International Space Station Flight Crew Integration Standard (NASA–STD–3000/T) was used as the basis for the payload labeling guidelines contained herein.

C.2 ISS PAYLOAD LABEL APPROVAL PROCESS

The PD is responsible for providing label drawings, label location drawings and information sufficient to enable IPLAT to determine the instructions herein are met. The PD will coordinate with IPLAT before submitting the label drawings for approval.

IPLAT is responsible for reviewing all payloads labels, providing guidance to the PD and granting approval based on the instructions herein. IPLAT is also responsible for performing a human engineering assessment of the labels and ensuring the labels are appropriate from a human engineering perspective, including commonality, standardization, and terminology.

The process for obtaining approval of ISS payload labels is shown in Figure C.1–1. IPLAT performs two evaluations. The initial label evaluation is performed at approximately the I–16 timeframe. This supports the start of crew training at I–13.5. The PD submits pre–released engineering drawings to IPLAT. Less formal materials are acceptable for this first review if they contain enough information for IPLAT to perform the evaluation. Upon receiving the drawings, or other materials, IPLAT has 10 working days to complete the evaluation. IPLAT will return a checklist that documents any requirement violations, and suggested solutions. The PD will then update the label designs based on IPLAT's recommendations.

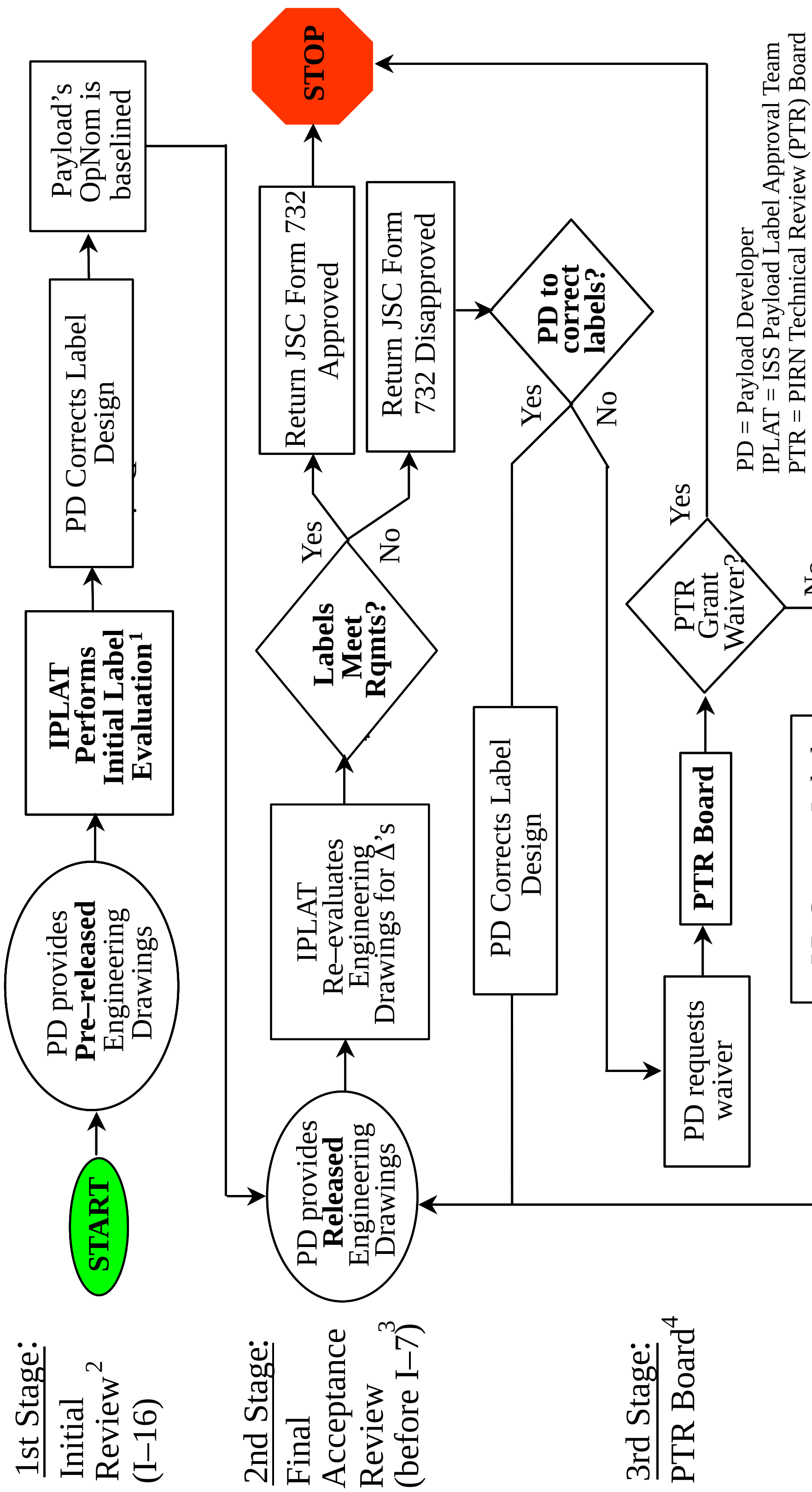
The final label evaluation is to be completed before I–7, enabling the payload to meet the I–7 deadline for final procedures review and baselining; followed by shipping of flight hardware to KSC by L–6. Before this final evaluation, the payload's Operations Nomenclature (OpNom), must be baselined. The PD submits released engineering drawings to IPLAT. IPLAT has 10 working days to complete this final evaluation. If the labels meet the requirements, IPLAT returns JSC Form 732, approved, to the PD. Form 732 is the PD's official verification that the labels meet the requirements, and should be included in the payload's verification record. If the labels still do not meet the requirements, the PD will correct the label design per IPLAT's recommendations.

The PTR is responsible for resolving issues and disagreements between the PD and IPLAT.

Once final approval has been granted via Form 732, the PD can manufacture labels, or order labels from the Decal Design and Production Facility (DDPF) via JSC Form 733.

C.3 IPLAT APPROVAL INSTRUCTIONS

IPLAT will use the following instructions in reviewing and providing the approval of payload labels.



PD = Payload Developer
IPLAT = ISS Payload Label Approval Team
PTR = PIRN Technical Review (PTR) Board

1 Completed within 10 working days
2 To support the start of crew training at I–13.5.
3 Supports baselining of procedures at I–7.
4 Only if IPLAT and PD disagree on resolution

FIGURE C.1–1 IPLAT PAYLOAD LABEL APPROVAL PROCESS

C.3.1 GROUND ASSEMBLY AND HANDLING

Labels used for ground assembly and handling must not interfere with on–orbit crew interface labeling. Product marking for ground assembly and handling should be in accordance with MIL–STD–130, section 4, except paragraph 4.1.c.

C.3.2 FUNCTION CONSIDERATIONS

A. Decals and placards must contain information required by the user regarding the purpose, the function, and/or the functional result of the use of equipment items. Engineering characteristics or nomenclature may be described as a secondary consideration.

B. Instrument decals and placards, for example, should be labeled in terms of what is being measured or controlled. Calibration data may be included where applicable.

C.3.3 PAYLOAD ORIENTATION

A. Payload labeling, displays, and controls must have a consistent rack vertical orientation arrangement with the rack vertical axis origin at the bottom of the rack hinge point.

B. Payload labels required for operations with the rack(s) rotated should be oriented with respect to required crew positions.

C.3.4 DELETED (MOVED TO C.3.5.4.1)

C.3.5 LABELING DESIGN

C.3.5.1 LABELING STANDARDIZATION

A. Standard decals needed by the PD which are available in JSC 27260, Decal Process Document and Catalog must either be obtained from the Decal Design & Production Facility (DDPF) or designed to be identical to them. Examples of labels found in the catalog are: IMS, fire hole, toxicology, hazardous, caution and warning, rack power switch, fire indicators, cable/hose labels, etc. The DDPF is also available to the PDs for fabricating labels not found in JSC 27260.

B. Labeling must be standardized between and within systems.

C. Deleted

D. Operations Nomenclature (OpNom)

(1) Non–IMS Hardware Labels – Nomenclature on all non–IMS hardware labels must conform to the operational nomenclature guidelines for content (characters used) provided in SSP 50254, Operations Nomenclature. The format for these labels is upper case, as required in paragraph E below.

(2) IMS Labels – When nomenclature is used above the bar code of an IMS label:

(a) Such nomenclature must conform to SSP 50254 guidelines for both content and format (mixed case).

(b) Such nomenclature must match the nomenclature on the hardware label, except that IMS label test is in mixed case, and hardware label test is in upper case.

E. Label Text

(1) Upper Case – Labels for equipment, displays, controls, switch positions, connectors, cables/hoses, LEDs, stowage containers, etc., must be listed in upper case letters only. This includes abbreviations and acronyms.

(2) Payload Name Labels

(a) Spelling Out vs. Acronyms – The name label for the “main unit” of a payload must spell out the name, followed by the acronym in parentheses, even if the acronym is an approved OpNom. The OpNom acronyms may then be used on all subordinate equipment. For example: The rack for SRF should spell out “SCIENCE RESEARCH FACILITY (SRF)”. All subordinate equipment may then use the SRF acronym, like “SRF ANALYZER MODULE”.

(b) Font size for name labels – The font size for the name label of an item should not be less than 12 point.

(3) Title nomenclature must be consistent with procedural handbooks and checklists.

F. General To Specific Principle – More general, or important information should be placed above or to the left on a label(s). Increasingly more specific, or less important information should be placed lower or to the right, with the most specific, least important information on the bottom or furthest right.

G. Keypads – Non–COTS keypads on payloads should use mixed case (upper and lower case) letters.

C.3.5.2 READABILITY

A. Decals and placards should be as concise and direct as possible.

B. Abbreviations

(1) Deleted

(2) Periods should be omitted except when needed to preclude misinterpretation.

C. Decal and Placard Life

Payloads must provide labels that are readable for the duration of the payload's operation, which are replaceable.

D. Language

(1) Decals and placards must be written in the English language.

(2) If dual languages are used, English must be used first and with lettering at least 25% larger than the secondary language.

E. Decals and placards should be designed so as to minimize visual clutter.

F. Illumination – Labels and markings should be designed to be read at all general illumination levels and color characteristics of the illuminant as specified in Table 3.12.3.4–2.

G. Displays and Controls Title Selection

(1) Physical Hardware – When verbs are used to label physical hardware (buttons, switches, controls, etc.), the present tense should be used. For example: OPEN or CLOSE, BEGIN, or END, START or STOP, etc.

(2) Physical Hardware Linked to Software Displays – If physical hardware is linked to and/or represented by software displayed data or controls (i.e. LCD), the labels for the physical hardware and the software representation must use the same terminology.

C.3.5.3 LABEL PLACEMENT

A. All labels must be placed on the payload hardware in accordance to the label location drawings.

B. Payloads Operated From Rack Front Panels – Payloads operated from the front panel of racks must be labeled in accordance to Figure C.3.5.3–1.

(1) Rack IMS Label – The rack IMS label must be located on the top left corner of the rack.

(2) Rack Name Label

(a) The rack name label must be located to the right of the rack IMS label.

(b) The rack name label must spell out the name of the rack. The acronym, if applicable, should follow in parentheses. The acronym may then be used on all subordinate equipment.

(c) The font size of the rack name label should be the largest one for the entire rack, at 48 point font, minimum.

(3) Subrack IMS Label – The subrack IMS label must be located on the top left corner of the subrack drawer.

(4) Subrack Name Label

(a) The subrack name label must be located to the right of the subrack IMS label.

(b) The subrack name label must spell out the name of the subrack. The acronym, if applicable, should follow in parentheses. The acronym may then be used on all subordinate equipment.

1. If this subrack is part of a facility rack (i.e., HRF, MSG, FCF, etc.), and will never be relocated into another rack, then the subrack name label need not include the facility's acronym (e.g. "WORKSTATION", as opposed to "HRF WORKSTATION").

2. If there are several related subracks that are considered a "sub–facility", the first such subrack must spell out the name of the sub–facility. The remaining subracks may use the acronym if they are co–located and below this subrack. For example, in Figure C.3.5.3–1, MICROBIOLOGY FACILITY is the name of the sub–facility, and is spelled out on the first subrack (in location B2), with the acronym following in parentheses. The remaining subracks only use the acronym.

(c) The font size of the subrack name label should be smaller than the rack name label, between 28 and 36 point.

(5) Subrack location codes must be placed on the inside of the rack post in accordance to Figure C.3.5.3–1.

C. Payloads Not Operated From Rack Front Panels – This section applies to all self–contained payloads other than those controlled from front panels (mounted elsewhere, not on the face of a rack like subrack payloads). Examples: SAMS II Remote Triaxial Sensor System, HRF Phantom Torso and DOSMAP, etc. See Figure C.3.5.3–3.

(1) The IMS label should be placed in the upper left corner of the dominant face of the payload.

(2) Payload Name Label

(a) The payload name label should be placed to the right of the IMS label.

(b) The payload name label must spell out the name of the payload if it is considered the "main unit". The acronym, if applicable, should follow in parentheses. The acronym may then be used on all subordinate equipment.

(c) The font size of the payload Name label should be the largest one for the entire payload.

D. Loose Equipment

(1) The IMS label should be placed in the upper left corner (if there is one) of the dominant face of the item. If there is no upper left corner, place the IMS label either to the extreme left (see Example L of Figure C.3.5.3–3), or at the top of the dominant face.

(2) Name Label

(a) If the dominant face of the item is populated with controls, the name label should be placed immediately to the right, or below the IMS label. If the dominant face is blank (such as a binder or stowage bag, as in Example B of Figure C.3.5.3–3), then the name label should be placed in the center of the face.

(b) Small Items – In the case of very small equipment items, an IMS label with the equipment's name in the text portion above the bar code is sufficient to satisfy both the IMS and Name label requirements.

E. Control Panel Labels

(1) Positions – Labels must be centered above connectors, switches, LEDs, displays, controls, etc. Labels may be placed in other locations when they cannot dimensionally fit in the required location, or if they would be obstructed by items like cables and hoses, or to preclude misassociation with adjacent items.

(2) Size – Labels for controls on a panel should be smaller than the name label for the panel and should be between 10 and 20 point font. Different levels of controls should be graduated in size. For example, grouping label titles should be larger than the labels for the controls within them. Similar levels of controls should be the same size. See Figure C.3.5.3–2 for examples.

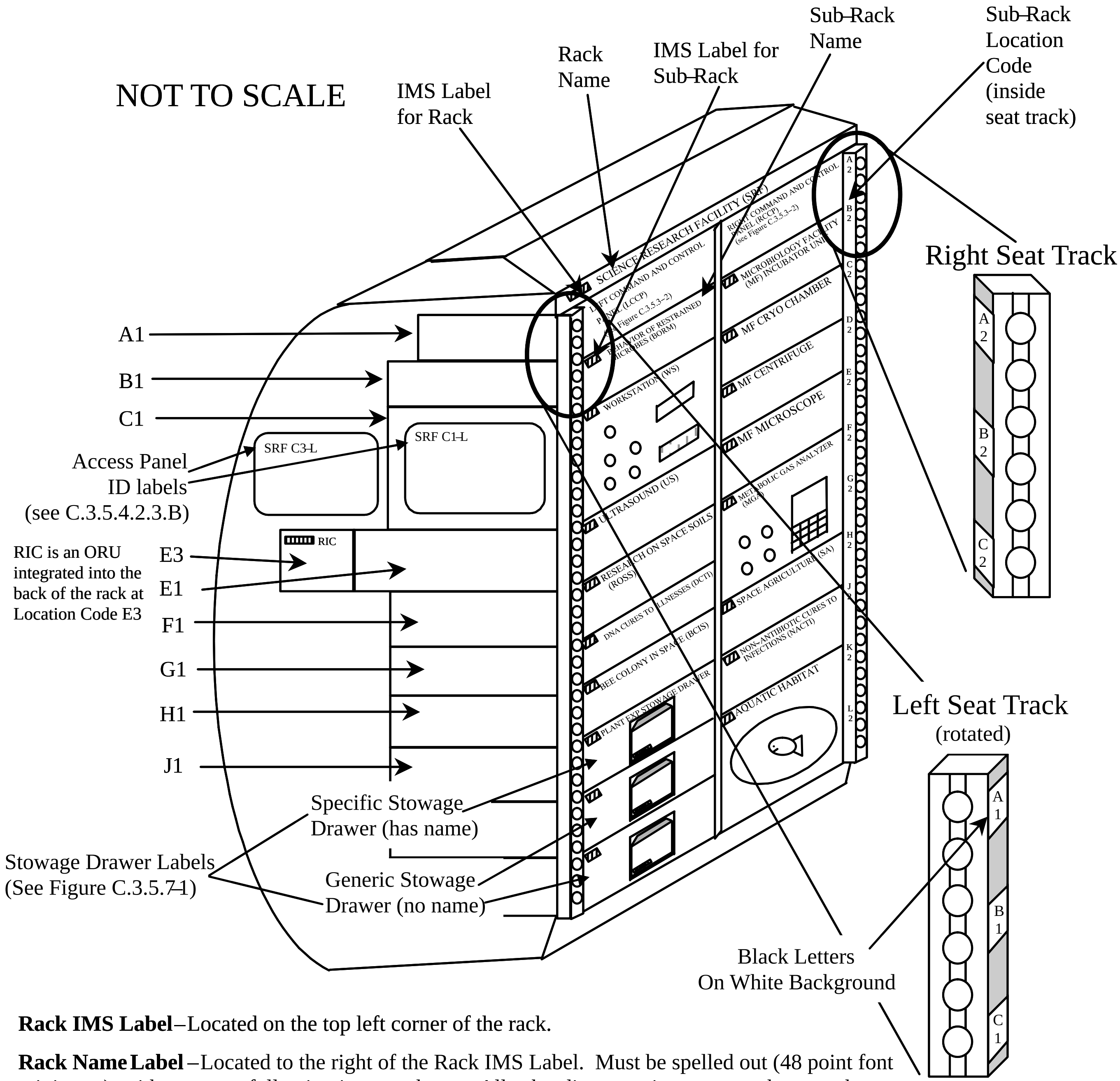
F. Part Number and Serial Number Labels – Part Number and Serial Number labels should be placed together for ease of identification. The Part Number label should be arranged to the left or above the Serial Number label. P/N and S/N, which are the standard OpNom representations of Part Number and Serial Number, respectively, should be used.

G. Orientation – All markings and labels must be oriented with respect to the local worksite plane so that they read from left to right. Vertical orientation, with letters arranged vertically if the text is short (e.g. DATA J3), or rotating the label 90 degrees when the text is long (e.g. PAYLOAD ELECTRONICS MODULE), is permissible when the marking or label does not fit in the required orientation.

H. Visibility – Labels must be placed on equipment so that they are visible when the equipment is used or accessed. Markings should be located such that they are perpendicular to the operator's normal line of sight whenever feasible and should not be less than 45 degrees from the line of sight.

I. Overhead Panels – On overhead panels, markings and labeling must be oriented such that they appear upright when observed from local vertical.

J. Association Errors – The arrangement of markings on panels should protect against errors of association of one marking or set of markings with adjacent ones.



Rack IMS Label–Located on the top left corner of the rack.

Rack Name Label–Located to the right of the Rack IMS Label. Must be spelled out (48 point font minimum), with acronym following in parentheses. All subordinate equipment may then use the acronym.

Subrack IMS Label–Located on the top left corner of the subrack drawer.

Subrack Name Label–Located to the right of the Subrack IMS Label. Must be spelled out (between 28–36 point font) with acronym following in parentheses. All subordinate equipment may then use the acronym.

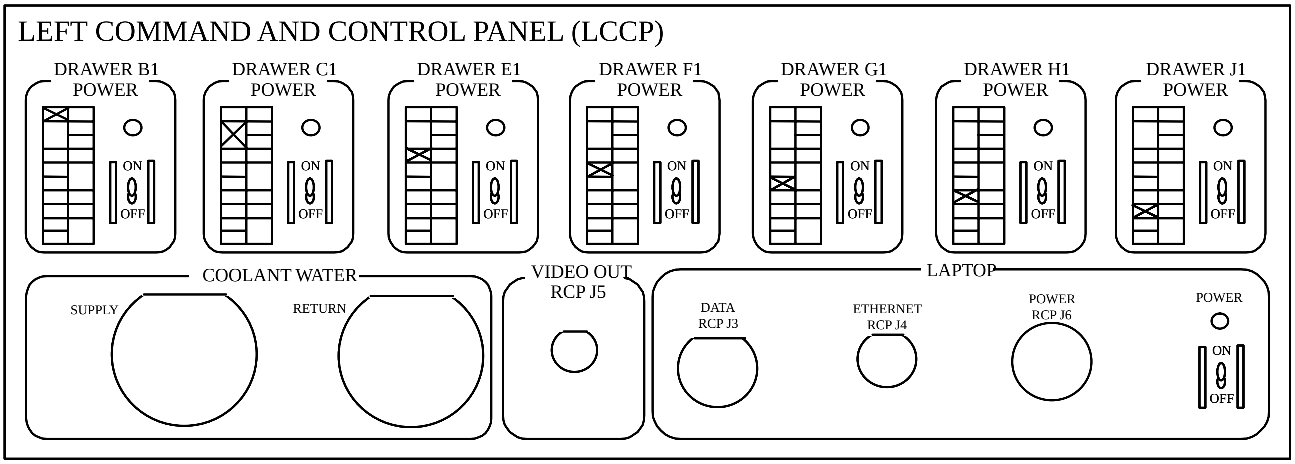
Subrack Location Codes–Located on the inside of the seat track. Letters A thru N, excluding I (18 point font). Letter/number pairs must be placed at intervals equal to the individual rack's smallest drawer unit (e.g. 4 PU (7 inches) for U.S. payloads, different for IP racks).

Note In above figure, MF is a sub–facility within SRF comprised of 4 subracks (B2 through E2). The name is spelled out on the first subrack. The acronym is then used on subsequent subracks.

FIGURE C.3.5.3–1 RACK LABEL PLACEMENT

NOT TO SCALE

This panel is at the ”A1” postion in Figure C.3.5.3–1:



This panel is at the ”A2” position in Figure C.3.5.3–1:

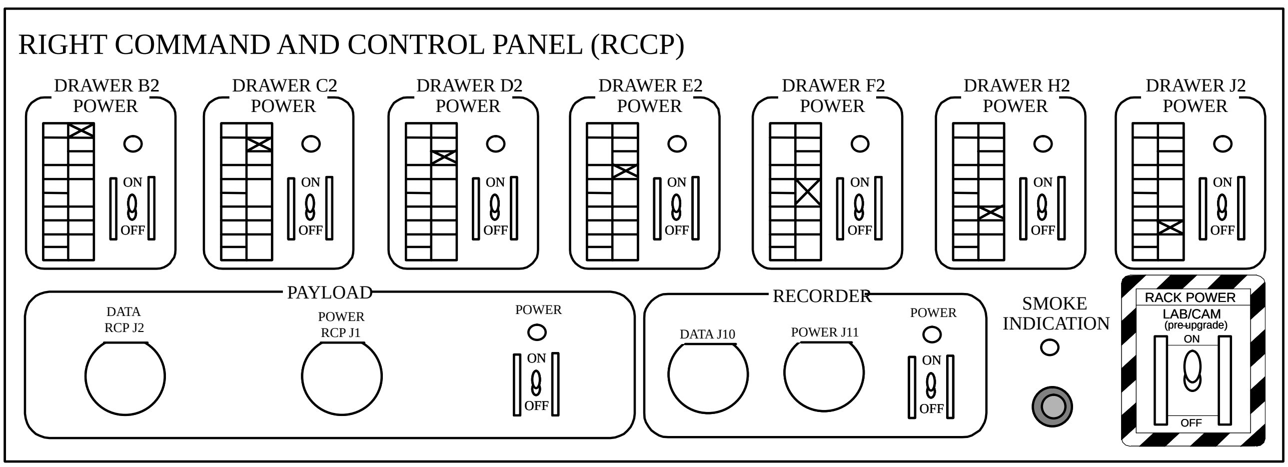
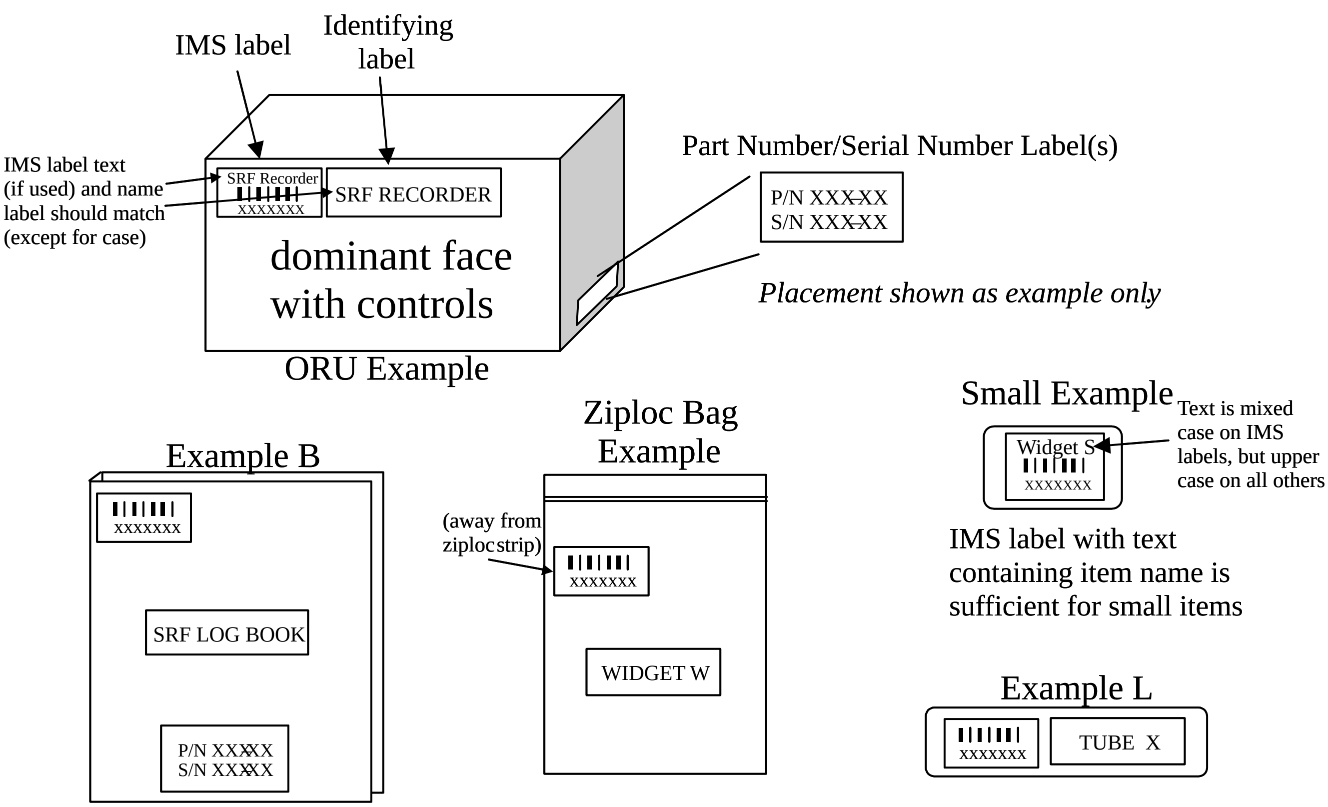


FIGURE C.3.5.3–2 CONTROL PANEL LABELING



Note: These are guidelines for standardization purposes. IPLAT recognizes that there may be many unique cases which will not fit these examples.

FIGURE C.3.5.3–3 MISCELLANEOUS LABEL PLACEMENT GUIDELINES

C.3.5.4 EQUIPMENT LABELING

C.3.5.4.1 EQUIPMENT IDENTIFICATION

A. All items on a payload must be identified with a label, including, but not limited to: displays, controls, switches, connectors, LEDs, containers, vents, etc., such that these items can be clearly referenced in crew procedures. Only those items whose use is obvious to the crew (e.g., food table, windows, etc.) are exempt from this instruction. The font size for these labels must be smaller than the main label naming the payload.

B. Containers must be labeled to identify their contents.

C. Loose equipment must be marked with nomenclature that describes the function of the item and its pertinent interfaces.

D. Multi–quantity Items

(1) Multi–quantity items that require individual distinction but are not serialized must be individually numbered. Control level items should be logically numbered/lettered left to right or top to bottom in descending order (e.g. “DRIVE A”, “DRIVE B”, “DRIVE C”).

(2) Serial Numbers – Multi–quantity items that are serialized should display the serial number as part of the identification.

(3) Containers containing multiple quantities of the same item should use a number in parentheses, after the name, to indicate the quantity (i.e. ”TEST TUBES (4)”, indicates there are four test tubes in the container).

E. Logos – If organizational or commercial logo(s) are used, they must not be distracting to the crew while operating the payload. For front panels, the size of a logo should be smaller than the main name label.

C.3.5.4.2 EQUIPMENT CODING

C.3.5.4.2.1 CABLE AND HOSE LABELING

A. Crew Interface Cables and Hoses Definition – Electrical cables and hoses *which are intended to be interfaced with by the crew* for nominal operations (e.g. experiment operations), planned maintenance (e.g. ORU replacement), or are designed to have a crew interface in the event of a contingency situation, are considered “Crew Interface Cables and Hoses”, and are subject to the format requirements below.

B. Crew Interface Cables and Hoses must be labeled to indicate the equipment to which they belong and the connectors to which they mate.

(1) Electrical Cable end Plugs and Corresponding Electrical Connector Ports

(a) The cable end plug must be designated with a “P” (e.g. P1), regardless of gender.

(b) The connector port on the hardware must be designated with a “J”, regardless of gender, and should be preceded by a descriptive name (e.g. DATA J1 or POWER J2).

(c) The plug number and receptacle number for a mating pair should be identical (e.g. P1 mates with J1), except when not possible because a cable is generic.

(2) Cable and Hose Label General Characteristics

(a) Font Size – The font size of the text on these labels should be 12 point preferred, or 10 point minimum.

(b) Text/Background Color – The text should be black on a white background.

(c) Abbreviations – When long names would result in an unreasonably large label, text can be abbreviated.

(d) Continuation Lines For Long names – Long names are discouraged, but if necessary, additional lines can be added to the cable/hose identification and ends labels described below.

(3) Cable and Hose Identifying Labels

(a) Cables and hoses must contain a main identifying label with the information below. This label must be placed at the mid–length position of the cable/hose, or at intervals not to exceed 2 meters for long utility lines. See Figure C.3.5.4.2.1–1 for examples.

– The name of the cable/hose. For a hose, if the pressure is known and constant, it should be indicated in parentheses after the name (e.g. psi). The flow direction should be indicated with an arrow below the name if the hose ends are not interchangeable.

– The Part Number of the cable or hose

– The Serial Number of the cable or hose (if applicable)

(4) Cable and Hose IMS Labels – A cable/hose must contain one (and only one) IMS label. It must be placed to the left of the main identifying label, at the mid–length position, as shown in Figure C.3.5.4.2.1–1. If the cable/hose requires multiple main identifying labels spaced at 2 meter intervals per #3 above, the IMS label should be placed at the center of the line.

(5) Cable and Hose End Labels – Labels at the terminal ends of cables/hoses must contain the information below. Vertical order, center justified, is the preferred arrangement. When the circumference of the cable/hose is too small to accommodate a label that wraps around the line with text arranged vertically, a flag style label should be used. For cases where wear and tear of such flags is a concern (i.e. through frequent use), a horizontal arrangement of the information is allowed as long as the text is short. See Figure C.3.5.4.2.1–1 for cable/hose label examples.

– First Line: The name of this end of the cable/hose (e.g. for cables, P1). For a hose, if the end does not have a specific identifier, this line may be left off. If the hose end needs to have a unique identifier, do not use a “P” number (”P”s are reserved for cables).

– Second Line: The word “TO” followed by the name of the piece of equipment to which this end of the cable/hose mates with. If this end can interface to multiple connector ports (e.g. generic cables), this line may be left off.

– Third Line: The exact name of the receptacle on the hardware that this end of the cable/hose mates with (e.g. DATA J1 or OXYGEN OUT). If this end can interface to multiple connector ports (i.e. generic cables), this line may be left off.

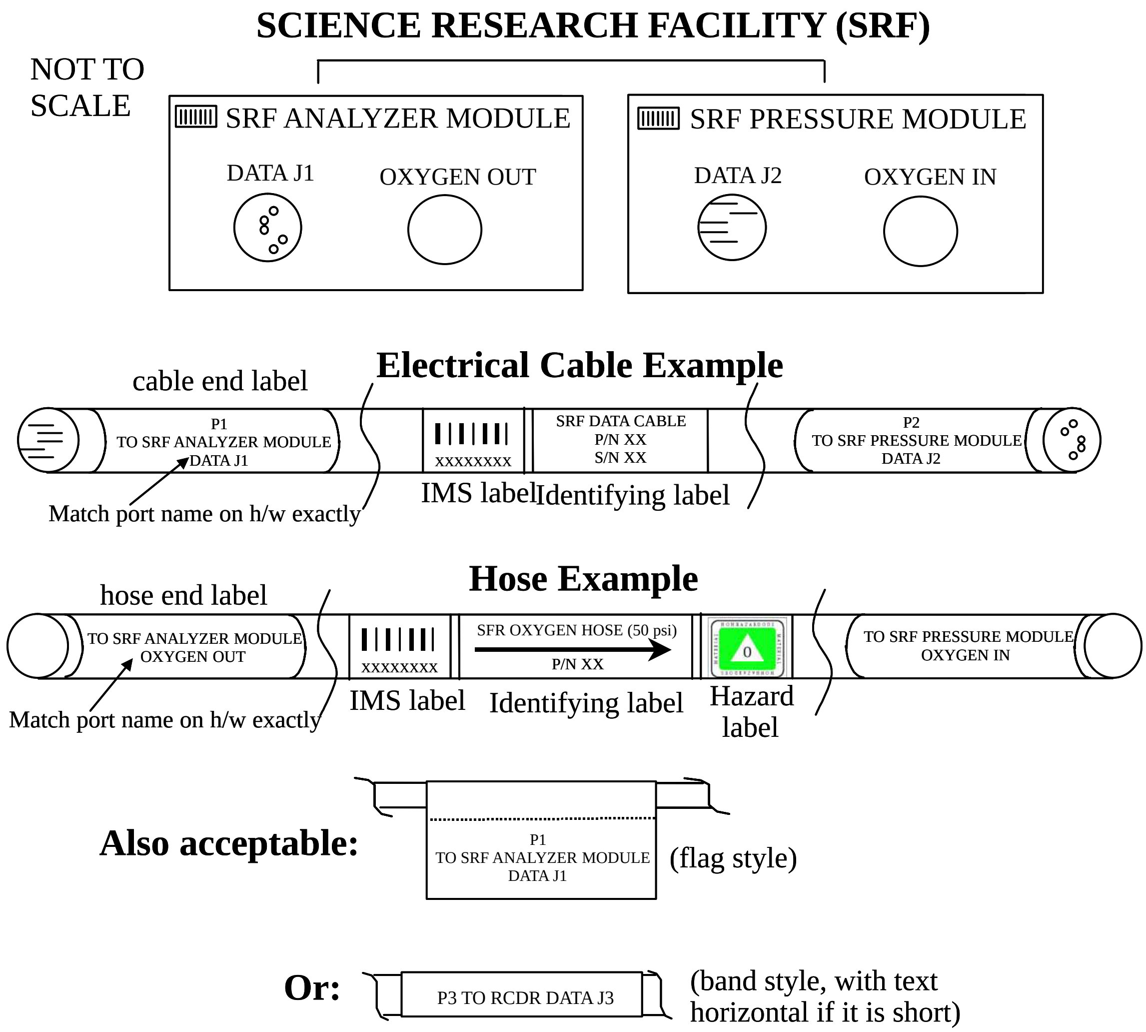
(6) Hose Hazard Labels – Hoses must have standard hazard class decals indicating the appropriate hazard level for the substance transported through the hose. This label must be placed to the right of the identifying label.

(7) Labels at the terminal ends of a payload utility line must contain the information below. Vertical order is the preferred arrangement. When the circumference of the utility line is too small to accommodate a label that wraps around the line with text arranged vertically, a tag, or flag style label should be used. For cases where wear and tear of such flags is a concern (i.e. through frequent use), a horizontal arrangement of the information is allowed. See Figure C.3.5.4.2.1–1 for cable label examples.

– The name of this end of the payload utility line (i.e. for cables, P1).

– The word ”TO” followed by the name of the piece of equipment to which this end of the payload utility line connects to. If this end can attach to multiple connector ports (i.e. generic cables), this requirement is not necessary.

– The name of the receptacle that this end of the payload utility line connects to (i.e. for cables, J1). If this end can attach to multiple connector ports (i.e. generic cables), this requirement is not necessary.



Notes:
Electrical cables/ports: "P" designates cable end plugs and "J" designates receptacles on hardware regardless of gender (pins/sockets).

Hose End Labels: The first line of the end label may be left off (as shown above) if the hose end does not have a specific identifier. In this case, only the second and third lines are needed. If hose ends must be identified, do not use a "P" number.

Hose Identifying Labels: Pressure should be indicated only if it is constant. Flow direction should be shown if the hose ends are not interchangeable.

FIGURE C.3.5.4.2.1–1 CABLE AND HOSE LABELING

C.3.5.4.2.2 COLOR CODING

A. Red must only be used to mark emergency use items. Yellow must only be used to mark Caution and Warning items. See section C.3.5.9 for Caution & Warning labeling requirements.

B. Hazard Labels – Hazard labels have their own, unique coding scheme, of which color is one factor. See section C.3.5.9.I for instructions.

C. Identification/Connectivity – Color coding used for component identification or to denote connectivity relationships must combine color with nomenclature (i.e. hardware name and the payload it belongs to, simple number, part number, etc.) such that when those components are referred to within procedures, it is clear which components the procedures are referring to. The only color restriction is listed in paragraph A (red and yellow cannot be used).

D. Color Difference

(1) Only one hue within a color category (e.g., blues, greens) should be used on the decals or placards within the same integrated rack.

(2) That color must always be associated with a single meaning within the same system or integrated rack.

E. Number of Colors – No more than 9 colors, including white and black, must be used in a coding system.

F. Markings/Background Color – Markings and background colors on labels must have sufficient contrast such that the labels are readable in ambient ISS lighting conditions. Labels should adhere to the accepted combinations of markings and background color listed below:

Markings	Background
Black	White
Black	Yellow
Black	Silver (metal photo labels)
White	Black
White	Red
White	Grey
Yellow	Blue
Red	White
Blue	Yellow

C.3.5.4.2.3 LOCATION AND ORIENTATION CODING

A. Subrack Location Codes:

(1) At the Rack level – Subrack location codes must be placed along the inside surface of the seat track at intervals equal to the individual rack's smallest drawer unit (e.g: 4 PU (7 inches) for U.S. payloads, different for IP racks), as shown in Figure 3.5.3–1. Each letter/number pair must be 18 point font and placed at the top of the particular drawer interval. Locations other than the inside of the seat track are permissible only if there is a permanent obstruction that would cover the labels.

(2) For Control Panels that Control Multiple Subracks – Each subrack's controls must be mapped to its location using the letter/number code (e.g. "A1", "A2", "B1", "B2", etc.), and a graphic (matrix with appropriate box checked) showing the individual locker's location in the rack. See Figure C.3.5.3–2 for examples.

B. Access Panels – maintenance access panels must be labeled to assist the crew in locating the panel for maintenance activities.

(1) Access panel identification labels should be located in the upper left corner position on the panel with respect to the local vertical orientation.

(2) Access panel identification labels for access panels on the side or back of a rack must be labeled as in Figure C.3.5.3–1 and include:

(a) The acronym for the rack (e.g. "SRF").

(b) Its height location using the subrack location code (e.g. "C3").

(c) Its left, right, or back location on the rack preceded by a hyphen (e.g. "–L" for left, "–R" for right, "–B" for back).

For example, a complete access panel label might be "SRF C3–L" or "SRF C3–R".

C. Alignment Marks/Interface Identification

(1) Alignment Marks – Alignment marks or other orientation markings must be used to aid the crew with the installation/mating of equipment when the hardware requires a specific orientation.

(2) Visibility – Alignment marks, arrows, or other labels showing required orientation must be visible during alignment and attachment.

(3) Tethered Equipment – Interface identification should not be used for movable items tethered to a mating part (e.g., dust cap for an electrical connector, hinged lid for a stowage container).

C.3.5.5 DELETED

C.3.5.6 OPERATING INSTRUCTION LABELS

Operating instruction labels are hardware labels (affixed to hardware) that contain procedural steps. The procedural text should be coordinated with the PODF prior to final IPLAT approval and conform to ODF standards as documented in ODF Standards, SSP 50253. See Figure C.3.5.6–1 for an example.

A. Location – Equipment operating instructions should be located on or adjacent to equipment.

B. Equipment Name – The instructions should have the title of the equipment to be operated centered above the text.

C. Grouping – Instructions should be grouped and titled by category (e.g., installation, removal, activation, calibration, etc.).

D. Title Selection – The titles of instructional text for equipment, displays, controls, switch positions, connectors, etc., must be in upper case letters only and bold.

(1) Title nomenclature must be consistent with procedural handbooks and checklists.

E. Instructional Text – Instructional text below titles must use upper and lower case letters. Direct references to hardware items should be in upper case so they match the hardware labels.

F. Required Tools – Instruction for removal of stowage items should list any tools required prior to the instructional text.

(1) When tools are required to remove stowage items, markings should be used for the location of the fasteners to be removed.

CAMERA EQUIPMENT OPERATING INSTRUCTIONS

Title in upper case and bold

<u>ACTIVATION</u>

Upper case and underlined

1. √BALLAST PWR ON/OFF (2) – OFF
2. Connect Ballast to main power supply
3. Connect Photoflood to Ballast
4. VOLTAGE PWR ON/OFF–ON
5. pb LIGHT ON – Press Hold (until Photoflood Light Illuminates)

Instructional text in mixed case, except for direct hardware label references.

<u>DEACTIVATION</u>

6. pb LIGHT OFF Press
7. Wait 10 minutes
8. VOLTAGE PWR ON/OFF – OFF

FIGURE C.3.5.6–1 OPERATING INSTRUCTION LABEL EXAMPLE

C.3.5.7 STOWAGE CONTAINER LABELING

This section applies to stowage containers provided by the payload, located within the payload, not in general ISS stowage containers.

A. Each stowage container must display the contents on its front surface visible to the crewmember.

For drawer, box, or bag style stowage containers that are mounted as subracks as in Figure C.3.5.3–1, the following requirements apply:

(1) The contents label should be as shown in Figure C.3.5.7–1a when the location is known and fixed. The contents label should be as shown in Figure C.3.5.7–1b when the location is not known or is variable.

(2) If the drawer/box/bag is being launched individually in the MPLM or the Space Shuttle Middeck, then the drawer must have the ascent label as shown in Figure C.3.5.7–1c, in the front of the pocket. This label is then removed upon transfer to ISS, revealing the label in Figure C.3.5.7–1a or C.3.5.7–1b.

B. Provisions should be made to permit in-flight revisions to or replacement of stowage labels on all stowage containers.

C. Subdivided Containers:

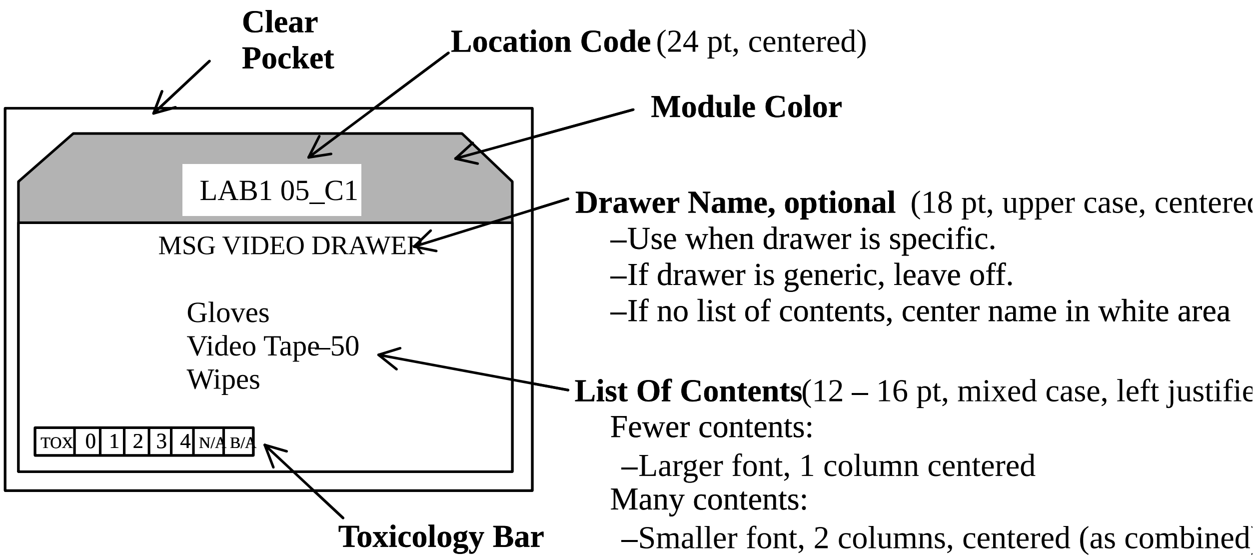
(1) If a stowage container is subdivided internally into smaller closed containers, the sub-containers must carry a list of contents.

(2) If the available marking space on a sub-container is insufficient to display the complete content titles, a contents list must be displayed elsewhere and clearly identified as belonging to the sub-container.

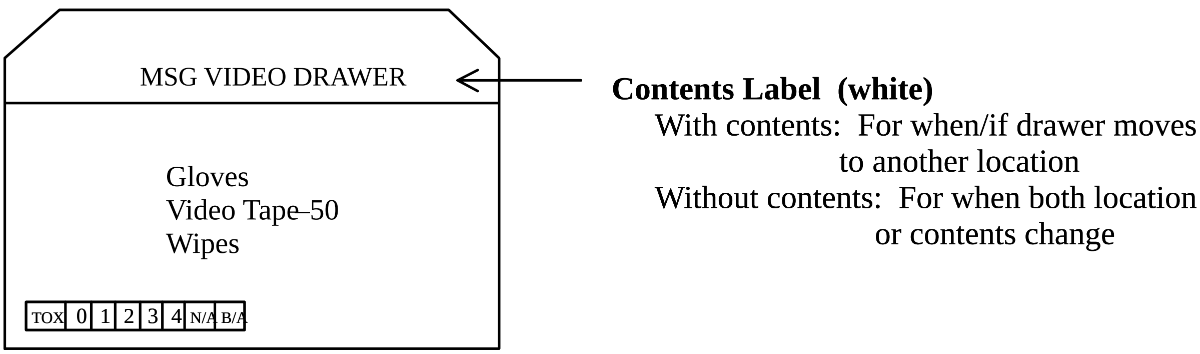
(3) The specific contents of each sub-container must be listed on the front surface of its container or near it.

D. Individual–Crew Items – Items allocated to a specific crewmember should be identified on the listing with the user’s title, name, or other coding technique.

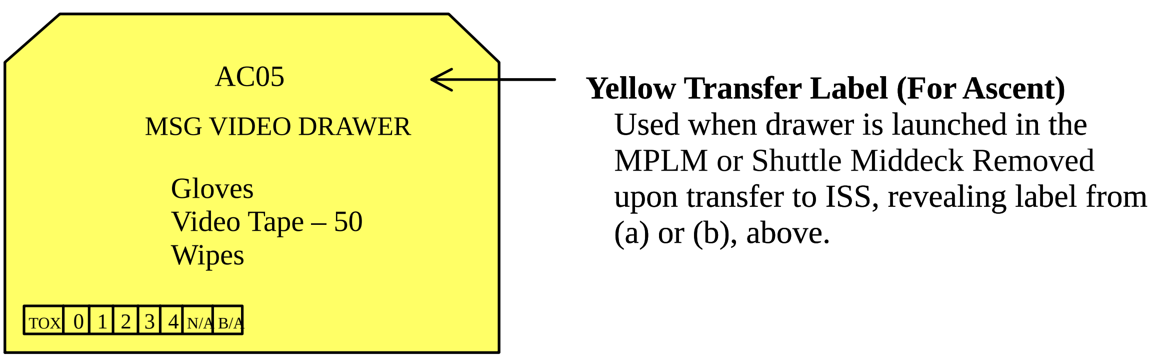
E. Tool/Accessory Kit Labeling – Containers with designated locations for placement of equipment set (e.g., socket wrenches in a tool kit) should have each location identified with the title of the item stowed.



a) Standard Drawer Title/Contents Label With Location Information



b) Standard Drawer Contents Label Without Location Information



c) Ascent Drawer Contents Label

Note: IPLAT must review the proposed label. The PD can then order this label from the Decal Design & Production Facility (DDPF). Reference Drawing #SEG32106109 “Crew Transfer Bag Standard Label”.

FIGURE C.3.5.7–1 STANDARD PAYLOAD STOWAGE DRAWER LABELS

C.3.5.8 GROUPED EQUIPMENT ITEMS

A. Functional groups of three or more equipment items (i.e. displays, controls, switch positions, connectors, LEDS, etc.) must be identified (e.g., by common color, by boundary lines). Functional groups of equipment items are all associated or connected with a common system or purpose. (e.g., CABIN AIR, FURNACE A, EXPERIMENT “M”, PANEL LIGHTING). Two functionally related items should be grouped when such grouping provides clarification of purpose and/or distinguishes them from surrounding items. See Figure C.3.5.8–1 for grouping label examples.

B. Labels must be located above the functional groups they identify.

C. When a line is used to enclose a functional group and define its boundaries, the labels must be centered at the top of the group, in a break in the line. When it is not possible to center the text at the top, the text may be placed elsewhere along the perimeter of the boundary line, but local vertical orientation or the text must be maintained.

(1) The width of the line must not be greater than the stroke width of the letters.

(2) The line must form an enclosed rectangle, or box, with rounded corners. Deviations from the rectangular shape are allowed when dimensional restrictions preclude a perfect rectangle.

D. When displays and controls are used together in adjustments or activation tasks, visible labels or markings must indicate their functional relationships.

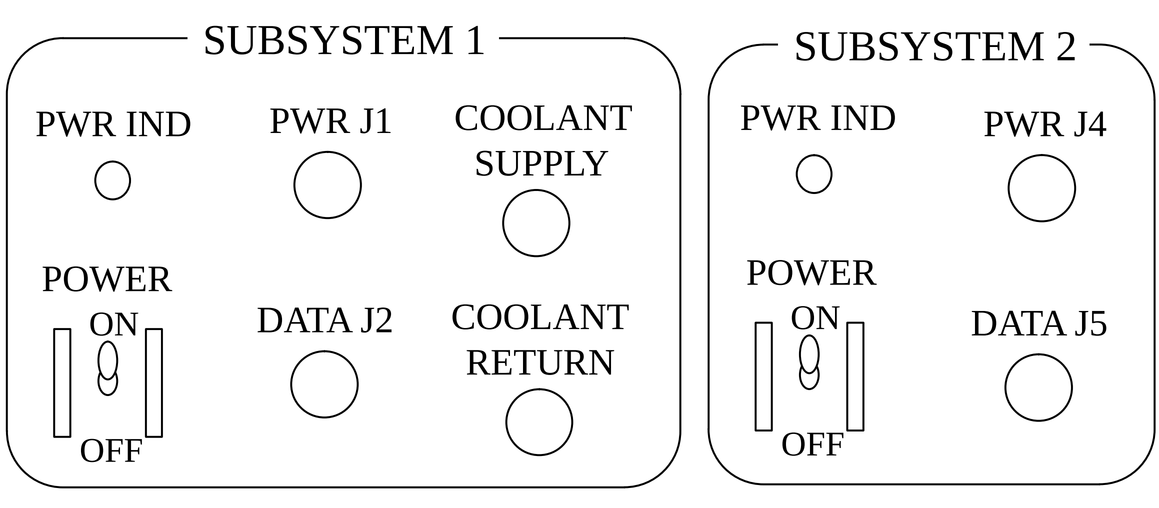


FIGURE C.3.5.8–1 GROUPING LABEL EXAMPLES

C.3.5.9 CAUTION AND WARNING LABELS

Caution and warning labels are required for indicating potentially undesirable conditions. See Figure C.3.5.9–1 for examples.

A. Caution and warning labels must be standardized between and within systems.

B. Caution and warning labels must be distinct from one another.

C. Caution and warning labels must identify the type of hazard and the action that would prevent its occurrence.

D. The caution and warning markings must be located in a visible area.

E. Emergency-Use Label Specifications

(1) Labels on emergency–use items (e.g., repair kits, emergency lighting, fire extinguisher, etc.) must be surrounded by diagonal red and white stripes either on the item or adjacent to it.

(2) The emergency type warning stripes must be alternate red and white.

(3) The red and white stripes should be of equal width.

(4) There must be no fewer than four red stripes and three white stripes.

(5) The striping must be applied at a 45 degree angle rotated clockwise from the vertical.

(6) The striping must begin and end with a red stripe.

(7) The text must be white letters on the red background or red letters on a white background.

(8) For items located within a storage container, the diagonal striping must be applied to the door of the container and the titles of the emergency items must be included on the marking.

F. Caution and Warning Label Specifications

(1) Caution/warning decals and placards must be surrounded by diagonal yellow and black stripes.

(2) The caution/warning type stripes must be alternate yellow and black.

(3) The yellow and black stripes should be of equal width.

(4) There must be no fewer than four yellow stripes and three black stripes.

(5) The striping must be applied at a 45 degree angle rotated clockwise from the vertical.

(6) The striping must begin and end with a yellow stripe.

(7) The text must be black letters on the yellow background.

G. Switches and Buttons

(1) The striping around a switch or button must not be wider than 25mm (1 in.) or narrower than 3 mm (0.125 in.).

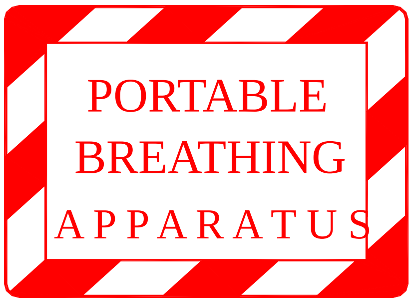
(2) If one side of a switch or button has less than 3 mm (0.125 in.) space, no striping must be applied to that side.

H. Deleted

I. Hazard Labels

(1) Chemicals – The standard hazard class decals must be used to identify the proper hazard class of payload chemicals (i.e. chemicals in solid, liquid, or gaseous states) as deemed by the payload's toxicology representative. The developer may obtain these decals from JSC 27260, Decal Process Document and Catalog, or must produce identical labels. See NSTS 07700, Volume 14, Appendix 9, section 5.6.3 for hazard class definitions.

(2) Other hazards – When biological, radiation, sharps, battery, or other hazards are identified by safety personnel, the appropriate standard label (if available) must be applied in a prominent location. The developer may obtain these decals from JSC 27260, Decal Process Document and Catalog, or must produce identical labels.



Emergency Label Example

Caution/Warning Label Example

Toxic Hazard Label Examples

FIGURE C.3.5.9–1 CAUTION AND WARNING LABEL EXAMPLES

C.3.5.10 ALPHANUMERIC

C.3.5.10.1 FONT STYLE

A. The font style used on decals, placards, and labels must be Helvetica or Futura demibold. If there are fit problems:

– The use of condensed type (Helvetica Condensed) or abbreviations is the preferred method of solving line length.

or

– For engraved markings which are not able to exactly match the above required font, the engraved marking should match the Helvetica font as nearly as possible.

Note: Helvetica is the preferred font.

B. Stenciled Characters – Stencil–type characters should not be used on display/control panels or other equipment.

C.3.5.10.2 PUNCTUATION

A. Periods & Commas – Periods (.) and commas (,) should not be used in equipment labels, except to preclude misinterpretation.

B. Hyphens – Hyphens (–) should not be used in equipment labels, except in part and serial numbers, and to preclude misinterpretation.

C. Parentheses and Ampersands – In general, parentheses and ampersands should not be used on payload equipment. Parentheses may be used to enclose acronyms after spelled out names (See section C.3.5.3) and to designate multiple quantities of an item (See section C.3.5.4.1.D.3). Ampersands may be used where the substitution of backslashes (/) would remove or distort the intended meaning (i.e. PUSH & HOLD vs. PUSH/HOLD).

D. Slashes – The slash (/) may be used in place of the words ”and” and ”or” and may be used to indicate multiple functions.

C.3.5.10.3 SPECIAL CHARACTER

A. Subscript and Superscript Size – Subscripts and superscripts should be 0.6 to 0.7 times the height of associated characters.

B. Subscripts – Numeric subscripts and upper case letter subscripts should be centered on the baseline of associated characters.

C. Lower Case Letter Subscripts – The base of lower case letters and the ovals of g, p, q, etc., should be at the same level as the base of adjacent capital letters.

D. Degree Symbol – The degree symbol should be centered on an imaginary line extended from the top of the F or C symbols.

E. Pound or Number Symbol (#) – The pound or number symbol should be centered on an imaginary line extended from the top of the associated numerals and placed two stroke widths away from them.

C.3.5.10.4 CHARACTER HEIGHT

A. Character Height – Character height depends on viewing distance and luminance level. At a viewing distance of 710 mm (28 in.), the height of letters and numerals should be within the range of values given in Table C.3.6.10.4–1.

B. Variable Distance – For a distance (D) other than 710 mm (28 in.), multiply the values in Table C.3.5.10.4–1 by D/710 mm (D/28 in.) to obtain the appropriate character height.

TABLE C.3.5.10.4–1 CHARACTER HEIGHT – 710 mm (28 in) VIEWING DISTANCE

Markings	Character Height	
	3.5 cd/m^2 (1ft–L) or below	Above 3.5 cd/m^2 (1ft–L)
For critical markings, with position variable (e.g., numerals on counters and settable or moving scales)	5–8 mm (0.20–0.31 in.)	3–5 mm (0.12–0.20 in.)
For critical markings, with position fixed (e.g., numerals on fixed scales, controls, and switch markings, or emergency instructions)	4–8 mm (0.16–0.31 in.)	2.5–5 mm (0.10–0.20 in.)
For noncritical markings (e.g., identification labels, routine instructions , or markings required only for familiarization)	1.3–5 mm (0.05–0.20 in.)	1.3–5 mm (0.05–0.20 in.)

C. Size Categories – Characters used in hierarchical labeling (e.g. rack name, subrack name, controls groupings, port names, etc.) should be graduated in size. There should be at least a 25 percent difference in the character height between each of these categories.

D. Space Limitations – The use of the same size letters and numerals for all categories on a label is acceptable for solving space limitation and clarity problems. The height of lettering and numerals should be not less than 3 mm (0.12 in.).

C.3.5.10.5 CHARACTER WIDTH

A. Letters – The width of letters should be 0.6 of the height, except for the letter ”I,” which should be one stroke in width, the letters ”J” and ”L”, which should be 0.5 of the height, the letter ”M”, which should be 0.7 of the height, and the letter ”W,” which should be 0.8 of the height.

B. Numerals – The width of numerals should be 0.6 of the height, except for the numeral ”4”, which should be one stroke width wider and the numeral ”1”, which should be one stroke in width.

C. Wide Characters – When wider characters are used on a curved surface, the basic height–to–width ratio should be increased to 1:1.

C.3.5.10.6 STROKE WIDTH

A. Height–to–Stroke Ratio – Marking letters and numerals should have a height–to–stroke ratio of 5:1 to 8:1.

B. Transillumination Background – Opaque markings on a transilluminated lighted background should have a height–to–stroke ratio of 5:1 to 6:1.

C. Transilluminated Markings – Transilluminated markings on a dark background or markings used on integrally lighted instruments should have a height–to–stroke ratio of 7:1 to 8:1.

D. General Purpose Illumination – Characters used on display panels and equipment when viewed under general purpose flood lighting or normal display conditions as specified in Table 3.12.3.4–2 should have a height–to–stroke ratio of 6:1 to 7:1.

C.3.5.10.7 CHARACTER MEASUREMENT

A. Measurement – All letters and numeral measurement should be made from the outside edges of the stroke lines for other than machine engraving on opaque surfaces.

B. Engravings – For all mechanical engraving on opaque surfaces, the dimensions controlling the size of letters and numerals should be measured from centerline to centerline of the stroke.

C.3.5.10.8 SPACE

A. Character Spacing – The spacing between letters within words and between digits in a multi–digit number should be the equivalent of one stroke width between two straight–sided letters such as H and l. (This instruction intended to accommodate the normal commercial typographical practice of spacing letters to achieve a, consistent visual continuity. This permits close spacing of open letters such as C and T to avoid large apparent gaps.)

B. Word Spacing – The spacing between words should be the equivalent of the letter W between two straight–sided letters such as N and F.

C. Line Spacing

(1) The spacing between lines of related text should be 0.5 of upper case letter height.

(2) Spacing between headings and text should be 0.6 to 1.0 of upper case letter height.

C.3.5.11 BAR CODING

PDs will coordinate with NASA/JSC organization OC for Inventory Management System (IMS) label registration.

A. Racks, subracks, stowage trays, loose equipment, consumables, and ORUs must have an inventory management label in accordance with SSP 50007. IMS labels, or their placeholders, must be present on engineering drawings. If the PD orders their IMS labels from the DDPF, the Decal Catalog decal part number should be included in a note on the engineering drawing.

B. Deleted

C. Deleted.

C.3.6 SCALE MARKING

A. Accuracy

(1) The precision of scale marking should be equal to or less than the precision of the input signal.

(2) In general, scales that are to be read quantitatively to the nearest graduation mark should be designed so that interpolation between graduation marks is not necessary. Interpolation should be limited to one half the distance between minor graduation marks.

(3) Scales should have a zero reference.

(4) If precise measurements are needed, scale graduation marks should be marked clearly to allow for unambiguous measurements.

B. Interval Values

(1) The graduation intervals should progress by 1, 5, or 2 units of decimal multiples thereof, in that order of preference.

(2) The number of graduation marks between numbered graduation marks should not exceed 9.

C. Scale Markings (High Luminance – above 1 ft–L)

(1) The minimum width of major, intermediate, and minor marks should be 0.32 mm (0.0125 in.)

(2) The length of major, intermediate, and minor graduation marks should be at least 5.6 mm, 4.1 mm, and 2.5 mm (0.22, 0.16, and 0.09 in.), respectively.

(3) The minimum distance between major graduation marks should be 13 mm (0.5 in.).

(4) Minor graduation marks may be spaced as close as 0.89 mm (0.035 in.), but the distance should be at least twice the stroke width for white marks on black dial faces and at least one stroke width for black marks on white dial faces.

D. Scale Markings (Low Luminance – below 1 ft–L)

(1) The minimum width of a major graduation should be 0.89 mm (0.035 in.), the minimum width of an intermediate graduation should be 0.76 mm (0.030 in.), and the minimum width of a minor graduation should be 0.64 mm (0.025 in.).

(2) The length of major, intermediate, and minor graduation marks should be at least 5.6 mm, 4.1 mm, and 2.5 mm (0.22, 0.16, and 0.10 in.), respectively.

(3) The minimum distance between major graduation marks should be 16.5 mm (0.65 in.).

(4) Graduation marks should be spaced a minimum of 1.5 mm (0.06 in.) between centerlines.

C.3.7 DELETED (MOVED TO C.3.6)

APPENDIX D EXHAUST GASES COMPATIBLE WITH THE ISS VES/WGS WETTED MATERIALS

TABLES

Data listed in this appendix document gases that have been verified as acceptable to vent to the ISS VES/WGS for compatibility with the systems wetted materials, as required according to 3.6.1.5 A. Gases listed in this appendix are required to meet all other requirements relating to venting, this appendix does not show verification with any of the other exhaust gas requirements. This appendix will be updated to reflect stage analyses, adding new gases to this appendix as they are analyzed.

TABLE D–1 EXHAUST GASES COMPATIBLE WITH THE USL VES WETTED MATERIALS (PAGE 1 OF 3)

Gas	Max Concentration	Additional Constraint
Acetaldehyde	100%	
Acetic Acid	100%	
Acetonitrile	100%	
Acetylene	100%	
Acrolein	100%	
Acrylonitrile	100%	
Argon	100%	
Benzene	100%	Note D1–3
Benzonitrile	100%	Note D1–3
1,3–Butadiene	100%	
n–butane	100%	
Butene	100%	
1–Butene	100%	
2–Butanone	100%	
Cabin Air	100%	
Carbon Dioxide	100%	
Carbon Monoxide	100%	
Chlorobenzene	100%	Note D1–3
Chloroethane	100%	
Chloromethane	100%	
cis–2–Butene	100%	
1,3–Cyclopentadiene	100%	
Cyclopentanone	100%	Note D1–3
Cyanogen chloride	100%	
Cyanogen bromide	100%	Note D1–3
n–Decane	100%	Note D1–3
1,1–Dichloroethane	100%	Note D1–3
1,1–Dichloroethene	100%	Note D1–3
Dichloromethane	100%	Note D1–3
Ethane	100%	
Ethene	100%	

TABLE D–1 EXHAUST GASES COMPATIBLE WITH THE USL VES WETTED MATERIALS (PAGE 2 OF 3)

Gas	Max Concentration	Additional Constraint
Ethanol	100%	
Ethyl benzene	100%	Note D1–3
Ethyl isopropyl ether	100%	Note D1–3
Ethyl methyl ether	100%	
2–Ethyl–4–Methyl–1,3–Dioxolane	100%	Note D1–3
Ethyl n–Propyl Ether	100%	Note D1–3
Formaldehyde	100%	
Heilum	100%	
n–hexanal	100%	Note D1–3
Hexane	100%	Note D1–3
Heptane	100%	Note D1–3
Hydrogen	100%	
Hydrogen cyanide	100%	
Hydrogen sulfide	100%	
Isopropanol	100%	
Isopropyl formate	100%	Note D1–3
Krypton	100%	
Methane	100%	
Methanol	100%	
Methyl acetate	100%	
Methyl acrylate	100%	Note D1–3
2–Methyl–2–butenal	100%	Note D1–3
1–(1–Methylethoyx)–2–Propanone	100%	Note D1–3
Methyl formate	100%	
Methyl methacrylate	100%	Note D1–3
2–Methyl propane	100%	
2–Methyl propenal	100%	
2–Methyl propene	100%	
Mixtures of gases in Appendix D1		Note D1–2
Neon	100%	
Nitrogen	100%	
Norflurane	100%	Note D1–3
Octane	100%	Note D1–3
o–Xylene	100%	Note D1–3
Oxygen	(not more than 30% by volume vented from the experiment chamber)	

TABLE D–1 EXHAUST GASES COMPATIBLE WITH THE USL VES WETTED MATERIALS (PAGE 3 OF 3)

Gas	Max Concentration	Additional Constraint
Pentanal	100%	Note D1–3
Pentane	100%	
Propadiene	100%	
Propane	100%	
Propanol	100%	
2–Propanone	100%	
Propene	100%	
n–Propyl acetate	100%	Note D1–3
Propyl formate	100%	Note D1–3
n–Propyl isopropyl ether	100%	Note D1–3
Propyne	100%	
Radon	100%	
Styrene	100%	Note D1–3
Sulfur dioxide	100%	
Sulfur hexafluoride	100%	Note D1–3
tert–Butyl alcohol	100%	
Toluene	100%	Note D1–3
1,1,1–Trichloroethane	100%	Note D1–3
Trichlorofluoroethane	100%	Note D1–3
1,2,4–Trimethylbenzene	100%	Note D1–3
2,2,4–Trimethyl–1,3–dioxolane	100%	Note D1–3
Vinyl acetate	100%	Note D1–3
Vinyl Chloride	100%	
Water Vapor	100%	
Xenon	100%	
m–Xylene	100%	Note D1–3
Note D1–1: Vented cabin air will contain small percentages of additional gases at up to the maximum levels defined in SSP 41000, Table VII, Spacecraft Maximum Allowable Concentrations (SMAC), or NHB 8060.1B, Appendix D. If the gases are not referenced in the above documents, the rack integrator shall use the Materials and Processes Technical Information System (MAPTIS) SMAC values. If MAPTIS is used, the rack integrator shall provide documentation for the SMAC values (including the date the information was taken from MAPTIS) as MAPTIS is not under configuration control. Cabin air particulates are limited to levels identified in SSP 41000, paragraph 3.2.1.1.1.15, capability: control Internal Carbon Dioxide and Contaminants.		
Note D1–2: Combinations of all gases must be analyzed and are constrained as specified to paragraph 3.6.1.5, this table only represents the gases that are compatible with the USL VES wetted materials.		
Note D1–3: Each proposed vent gas with a molecular weight greater than 75 amu shall be analyzed in accordance with 4.3.6.1.5C.		

TABLE D–2 EXHAUST GASES NOT COMPATIBLE WITH THE USL VES WETTED MATERIALS

Gas	Notes
Hydrogen bromide	Note D2–1
Hydrogen chloride	Note D2–1
Hydrogen fluoride	Note D2–1
Hydrogen iodide	Note D2–1
Nitric acid	Note D2–1
Nitrogen dioxide	Note D2–1
Nitrogen tetroxide	Note D2–1
Perchloric acid	Note D2–1
Phosgene	Note D2–1
Phosphoric acid	Note D2–1
Sulfuric acid	Note D2–1
Note D2–1: These gases shall be containerized, stored, or transported by the integrated rack per 3.6.1.5.3 unless the concentrations of the gases are no more than the maximum levels defined in SSP 41000, Table VII, SMAC or NHB 8060.1B, Appendix D. If the gases are not referenced in the above documents, the rack integrator shall use the MAPTIS SMAC values. If MAPTIS is used, the rack integrator shall provide documentation for the SMAC values (including the date the information was taken from MAPTIS) as MAPTIS is not under configuration control.	

TABLE D–3 EXHAUST GASES COMPATIBLE WITH THE JEM WASTE GAS SYSTEM WETTED MATERIALS

GAS	Max Concentration	Additional Constraint
Nitrogen	100%	
Cabin Air	100%	
Noble Gases	100%	
Carbon Dioxide	100%	
Oxygen	Less than 24.1% by volume	
NOTE 1: Vented cabin air will contain small percentages of additional gases at up to the maximum levels defined in SSP 41000, Table VII, Spacecraft Maximum Allowable Concentrations (SMAC), and NHB 8060.1B, Appendix D. Cabin air particulates are limited to levels identified in SSP 41000, paragraph 3.2.1.1.1.15, Capability: Control Internal Carbon Dioxide and Contaminants.		
NOTE 2: Combinations of all gases must be analyzed and are constrained as specified to paragraph 3.6.1.5, this table only represents the gases that are compatible with the JEM WG wetted materials.		
NOTE 3: The gases which are not described in this table shall be verified to be compatible with the materials in JEM wetted surfaces defined in SSP 41002, paragraph 3.3.7.2, Interface Characteristics.		
NOTE 4: Each proposed vent gas with a molecular weight greater than 75 amu or a boiling point greater than 100 deg C (212 deg F) at atmospheric pressure shall be analyzed in accordance with 4.3.6.1.5.C to determine whether or not the integrated rack provides a means to remove gases that would adhere to the ISS VES/WGS tubing walls at a wall temperature of 4 deg C (40 deg F) and at a pressure of 10(–3) torr.		

TABLE D–4 EXHAUST GASES NOT COMPATIBLE WITH THE JEM WASTE GAS SYSTEM WETTED MATERIALS

Gas	Notes
No gases identified to date	

TABLE D–5 EXHAUST GASES COMPATIBLE WITH THE APM WASTE GAS SYSTEM WETTED MATERIALS

GAS	Max Concentration	Additional Constraint
List not completed to date		
NOTE 1: Vented cabin air will contain small percentages of additional gases at up to the maximum levels defined in SSP 41000, Table IX, Spacecraft Maximum Allowable Concentrations (SMAC), and NHB 8060.1B, Appendix D. Cabin air particulates are limited to levels identified in SSP 41000, paragraph 3.2.1.1.1.15, Capability: Control Internal Carbon Dioxide and Contaminants.		
NOTE 2: Combinations of all gases must be analyzed and are constrained as specified to paragraph 3.6.1.5, this table only represents the gases that are compatible with the APM WG wetted materials.		

TABLE D–6 EXHAUST GASES NOT COMPATIBLE WITH THE APM WASTE GAS SYSTEM WETTED MATERIALS

Gas	Notes
No gases identified to date	

APPENDIX E OPEN ITEMS

E.1 TO BE DETERMINED ITEMS

TABLE E–1 TO BE DETERMINED ITEMS

TBD No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
1					

E.2 TO BE RESOLVED ITEMS

TABLE E–2 TO BE RESOLVED ITEMS

(Page 1 of 2)

No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
3	ESA does not agree with the relaxation of the NTSC Video Performance Characteristics defined in Table 3.4.1.1–1. ESA requires that Payloads meet the “RECOMMENDED” values in Table 3.4.1.1–1 to be compatible with the APM video system.	3.4.1.1–1	ESA NASA OZ3	9/1/00	
6	NASDA does not concur with the defined equivalent shielding thickness of 25.4 mm defined in Section 3.9.3.3. NASDA proposes to change the equivalent shielding thickness to 4.8. NASA to provide the technical rationale used to derive an equivalent shielding thickness of 25.4 mm of aluminum.	3.9.3.3	NASDA JEM NASA OZ3	9/1/00	
7	Additional thermal boundary conditions are required to allow Payloads to perform the necessary design analysis to insure that their hardware design will be compatible with the JEM. NASA to incorporate the JEM thermal interface boundary requirements for integrated racks.	Table 3.9.4–1	NASDA JEM Boeing/PEI	9/1/00	
8	Thermal Conditions – APM module wall temperature	Table 3.9.4–1	ESA/McGrath	9/1/00	
9	Thermal Conditions – CAM module wall temperature	Table 3.9.4–1	NASDA / Centrifuge Project	3/1/01	

TABLE E–2 TO BE RESOLVED ITEMS

(Page 2 of 2)

No.	Description	Document Section	Responsible	Due Date	Resolution and Closure Date
10	NASDA is unsure as to whether parameter monitoring can provide for automatic shut–off function of payloads in response to a potential fire event. What are the joint NASA/NASDA verification methods of this capability. NASA to provide NASDA the details of the MBF and PSIV software verification functions.	3.10.2.2	NASDA JEM NASA OZ3	9/1/00	
12	ESA requires additional time to assess the verification methodology defined in this requirement before they can concur with this section.	4.3.6.1.5.B	ESA/McGrath	9/1/00	
14	NASDA–CR/LSG requires additional time to assess possible technical impacts to their hardware.	3.11.2 4.3.11.2	NASDA–CR/ LSG	2/14/02	
15	NASDA–CR/LSG requires additional time to assess possible technical impacts to their hardware.	3.3.7 4.3.3.7	NASDA–CR/ LSG	2/14/02	
16	ESA cannot concur with PIRN 57000–NA–0253D until successful testing is completed on the Node 2 / Columbus APM HRDL interface.	3.3.7 4.3.3.7	ESA/McGrath	4/15/04	

APPENDIX F INSTRUCTIONS FOR HUMAN FACTORS IMPLEMENTATION TEAM (HFIT) VERIFICATION

F.1 INTRODUCTION

The ISS Human Factors Implementation Team (HFIT) provides an optional service to review and approve Human Factors requirements applicability for all payload equipment that the crew will interface with during nominal operations, planned maintenance, and contingency operations.

Appendix F provides the instructions for the approval of payload Human Factors requirements. The verification of Human Factors requirements will be a joint process requiring the cooperative efforts of the HFIT and the PD. The process for Human Factors approval, by HFIT, is documented in Figure F–1.

F.2 ISS PAYLOAD HUMAN FACTORS REQUIREMENTS APPROVAL PROCESS

F.2.1 INTRODUCTION

This document provides the instructions for the approval of payload Human Factors requirements in order to comply with Space Station Program (SSP) 57000 section 3.12 specifications. The development of this set of instructions is to provide assistance to the Payload Developer (PD) with the verification of Human Factors requirements listed in Form 881 of "Human Factors Implementation Team (HFIT) Verification/Certification" and SSP 57000 section 3.12. The HFIT will be a joint effort requiring an Astronaut Crew Representative, NASA Human Factors and Boeing Human Factors representatives.

F.2.2 RESPONSIBILITIES

The Payload Developer is responsible for complying with all requirements listed in SSP 57000 section 3.12. The HFIT will certify payload compliance by means of PD drawings, photos, measurements and/or any other required information needed to complete evaluation of program Human Factors requirements. The PD will coordinate with the HFIT before submitting data for approval. The HFIT is responsible for reviewing all data for payload human factors criteria for the SSP 57000 3.12 requirements listed in Form 881. Granting approval is based on the instructions herein. The HFIT is also responsible for performing the on site human engineering verification of the hardware and ensuring that the hardware is usable from a human engineering perspective, including commonality, standardization, and operations.

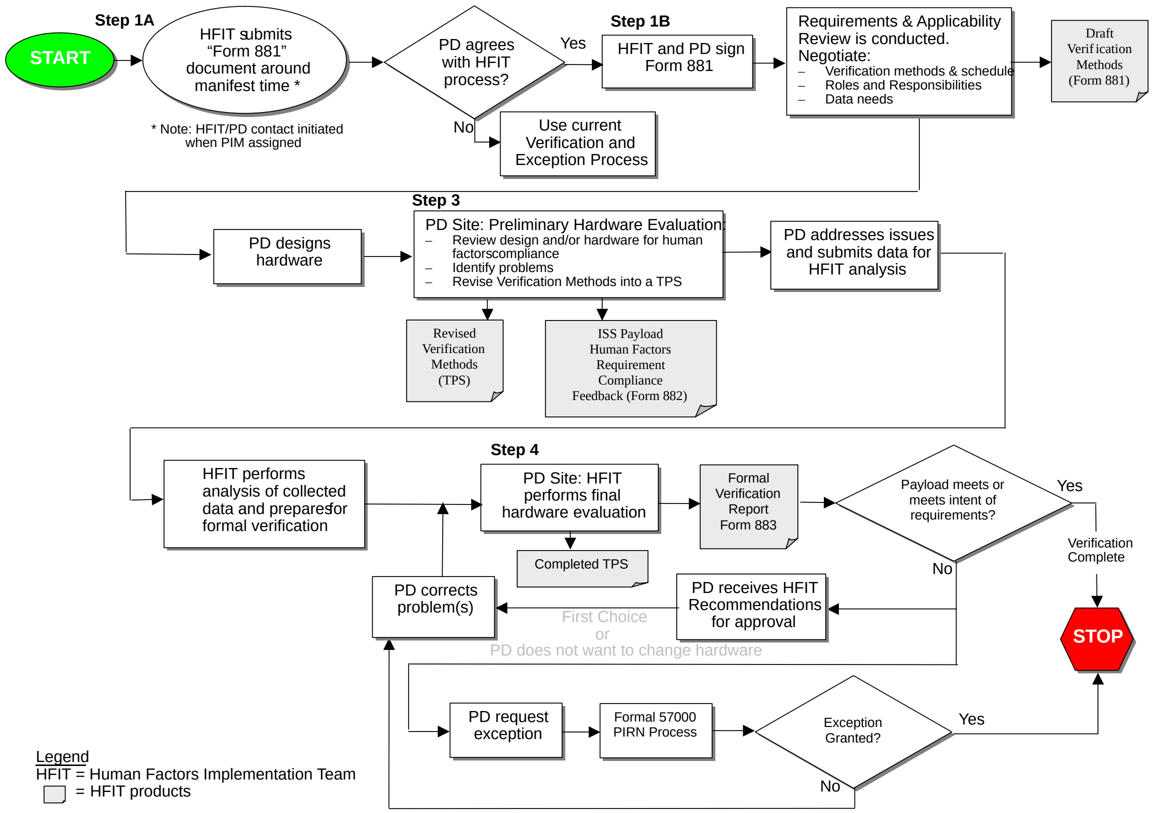


FIGURE F–1 HFIT PAYLOAD HUMAN FACTORS APPROVAL PROCESS

Upon receiving Form 881 from the HFIT, the PD and the HFIT will assess/verify through vendor or on site inspection, the hardware indicated on Form 881. This data will be collected by the HFIT with the help of the PD. The PD will aid the HFIT by providing any data collected as a result of design or hardware modeling.

The Payload Control Board (PCB) is responsible for resolving issues and disagreements between the PD and the HFIT.

F.2.3 HFIT APPROVAL INSTRUCTIONS

The HFIT will use the following instructions in reviewing and providing the approval of payload Human Factors requirements on Form 881 of "Human Factors Implementation Team (HFIT) Verification/Certification". Verification data can be obtained and presented in the forms listed on Form 881 by the HFIT and/or the PD. Space Station Program (SSP) 57000 will be used to evaluate the hardware for acceptance.

Step 1 (A) The HFIT will submit Form 881 (with the help of the PD) for approval. The acknowledgement of these requirements and contact with the HFIT representative is the first step. This should occur at the time a Payload Integration Manager (PIM) is assigned or Payload is manifested.

Step 1 (B) Signed concurrence on Form 881 by the PD point of contact and the HFIT may occur at a time negotiated by the PIM and the HFIT. If contact is not made, or concurrence is not obtained, the PD will use the existing SSP 57000 process flow for exceptions. Contact by the PD will generate a file by the HFIT and begin the Form 881 and 883 of “ISS Human Factors Final Disposition” processes.

Step 2 Requirements and Applicability Review. This happens at the PDR, CDR, or at a time negotiated by the PIM and the HFIT. This is a formal review conducted by the HFIT and the PD to ensure either the HFIT review or the formal SSP 57000 exceptions process is resolving requirements issues. All tools and procedures will be used with PD concurrence to obtain data for Form 881 as negotiated with HFIT.

Step 3 The Preliminary Hardware Evaluation Report. During this process a form 882 “ISS Payload Human Factors Requirements Compliance Feedback Form” can be used to note hardware discrepancies either by the HFIT or the PD. This happens from ICD approval time until L–10. This step will complete any SSP 57000 section 3.12 Human Factors issues and allow the PD to close out the HFIT process. The data collected by the PD and the HFIT will complete the HFIT requirements process and issue the COCs for requirements met at that review.

For minor exception to the SSP57000 section 3.12 requirements, the HFIT can accept the design if it is evaluated and found to be operable and safe for the crew. This will be documented in a specific section of Form 881.

Step 4 The Final Hardware Evaluation. A closed Form 881 completes this. A review is conducted by the HFIT no later than L–10. The HFIT will only give a Form 883 payload compliance with SSP 57000 section 3.12 requirements when all hardware issues are resolved with the exception of sections 3.12.3.2 Touch Temperature, 3.12.3.3 Acoustic Requirements, 3.12.3.3.1 Noise Limits and 3.12.7 Identification Labeling. These requirements will be completed through the formal process described in SSP 57000. The HFIT, in Form 883, lists all drawings applicable to the certified hardware and all SSP 57000 section 3.12 requirements that could not be met by this process. Acknowledgement of the waived condition is noted by the HFIT on Form 883. Once all requirements listed in Form 881 are met and all 882 discrepancies are closed a Form 883 compliance form will be issued for the COFR. Boeing PEI Human Factors will track all non–compliances.

MEMBERS AND FUNCTION

1) **Astronaut Crew Representative:** This is any member of the Astronaut Crew who has signature status granted by the Astronaut Office (CB).

2) **NASA Human Factors Representative:** This is any member of the NASA Human Factors Group who has signature status granted by NASA JSC Habitability and Human Factors Office (SF3).

3) **Boeing Human Factors Representative:** This is any member of the Boeing Human Factors Group who has signature status granted by Boeing PEI.

4) **OZ3 or Boeing Management Representative:** This is a Payload Hardware Engineering Integration Office (OZ3) or a Boeing PEI Management Representative who has signature status granted by their management.

SIGNATURES

All members listed below have agreed upon the Human Factors Implementation Team (HFIT) process charter and Form 881 and its processing language. A completed copy of Form 881 will be filed with all parties listed in the Members signature blocks of this form for the duration of the payload's use on the International Space Station (ISS). A Form 883 will be issued upon completed Form 881 as the payload's Certificate of Compliance.

Members:

1) Astronaut Crew Representative

2) Payload Developer (or Payload Integrator) Point of Contact

3) NASA Human Factors Representative

4) Boeing Human Factors Representative

5) OZ3/Boeing Management Representative